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The Ottawa Field-Naturalists' Club

FOUNDED IN 1879

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His Excellency The Right Honourable Roméo LeBlanc, P.C., C.C., C.M.M., C.D.,
Governor General of Canada

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Back Numbers and Index

Most back numbers of this journal and its predecessors, *Transactions of The Ottawa Field-Naturalists' Club*, 1879-1886, and *The Ottawa Naturalist*, 1887-1919, and *Transactions of The Ottawa Field-Naturalists' Club and The Ottawa Naturalist – Index* compiled by John M. Gillett, may be purchased from the Business Manager.

Cover: Ram's-head Lady's-slipper (*Cypripedium arietinum*) is an orchid species with notable colonies in the Ottawa District. Detail of drawing by Susan Laurie-Bourque. See species account pages 57-60.

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Volume 111

1997

THE OTTAWA FIELD-NATURALISTS' CLUB

OTTAWA

CANADA

The Canadian Field-Naturalist

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The Orchids in the Ottawa District: Floristics, Phytogeography, Population Studies and Historical Review

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Reddoch, Joyce M., and Allan H. Reddoch. 1997. The orchids in the Ottawa District: Floristics, phytogeography, population studies and historical review. *Canadian Field-Naturalist* 111(1): 1–185.

The Ottawa District is the area within 50 km of the Peace Tower of the Parliament Buildings in Ottawa, Ontario, Canada. Within these parts of eastern Ontario and western Quebec, 44 species of orchids have been recorded since 1856. Of these, six species are provincially rare in Ontario and 13 in Quebec. This report is presented as a baseline study from which to design further research and prepare effective planning measures to protect wild orchid populations. It includes information on identification, past abundance, population changes, development cycles and relative stability of colonies. The history of collecting and recording (including the work of the Native Orchid Location Survey), principal orchid habitats, local distribution patterns, rare species, colour forms and other topics are discussed in an introductory section. Detailed information on these topics is presented for each species, when relevant, together with a brief description of the plant, the overwintering shoot, capsules and seeds, blooming dates and colony sizes, all based on herbarium specimens, literature and 30 years of field observations. An illustration and a spot distribution map accompany each species account. Long-lived colonies of many species are described, and detailed population studies are included for *Corallorhiza striata*, *Goodyera pubescens*, *G. tessellata*, *Platanthera hookeri*, *P. orbiculata* and *Spiranthes cernua*. The distributions of some species are shown to correlate with the Canadian Shield or the St. Lawrence Lowlands, or with calcareous rock, sandstone or sand deposits.

Key Words: orchids, distributions, floristics, historical review, phytogeography, population studies, spirality, Ottawa District, Ontario, Canada.

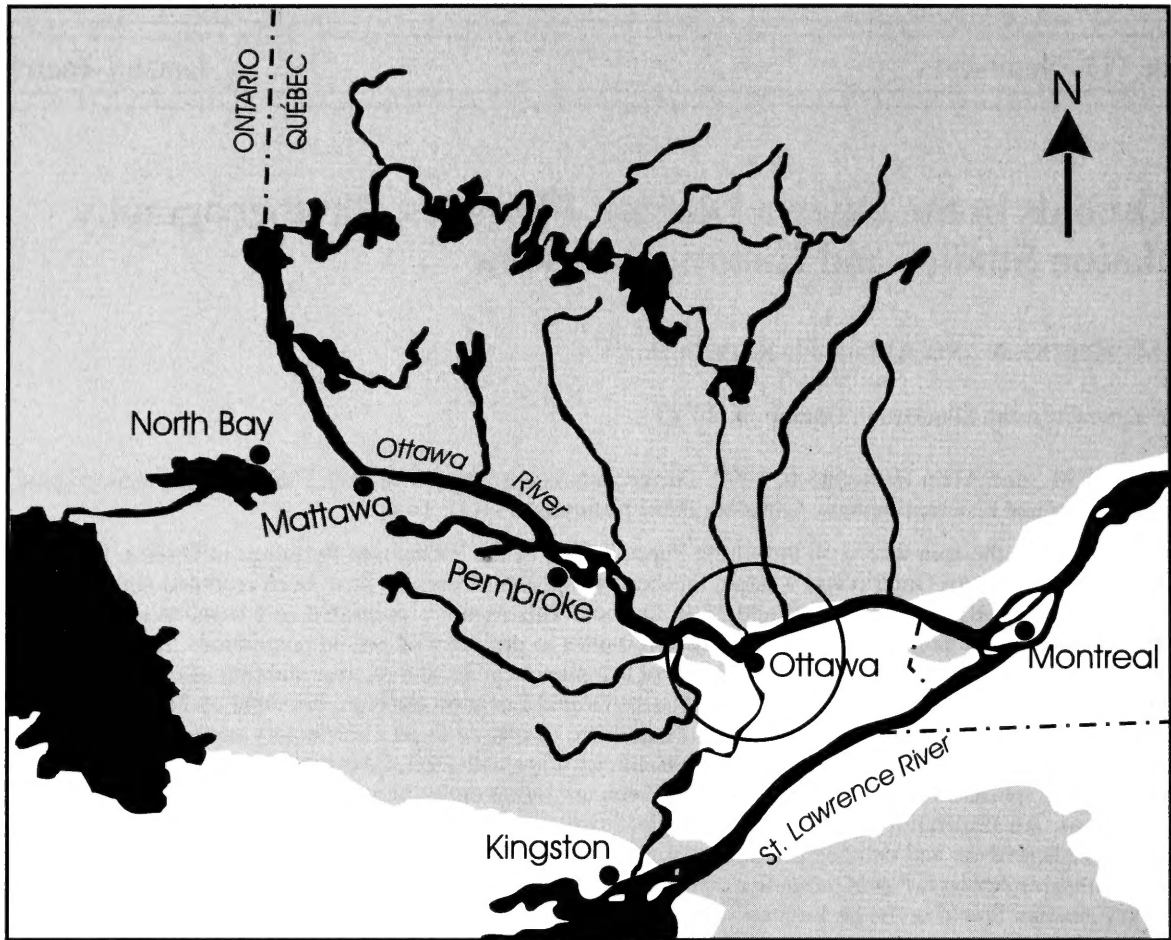
Forty-four species of orchids have been found within 50 km of the Parliament Buildings in Ottawa. This total for such a small area is the consequence of an interesting geological history and the resulting rich diversity of habitats. It is also the product of the coincidental overlap of the ranges of orchids of the boreal forest, the deciduous forest, the prairie and the coastal plain on an already rich Great Lakes - St. Lawrence flora. In addition, human disruption of the natural landscape over the past two centuries, while destroying many habitats, has created new ones and augmented others. Moreover, Ottawa, being the national capital, has attracted an unusual concentration of scientifically-trained individuals, who for a century and a half have studied the local flora.

It is our goal that this paper contribute to a better understanding of floristic biodiversity in this region and provide information that will permit effective monitoring and management of wild orchid populations. We review the knowledge gained since 1856 and, in addition, report on our own observations and population studies since 1966. The treatment of each species emphasizes quantitative treatment of heights, flower numbers, colony sizes and blooming dates, as well as correlations of distributions with relevant geological features. We report flower colours using standardized colour nomenclature and describe habitats, long-lived colonies and early collections. For some species we report studies of annual population variation and seasonal development.

The Ottawa District

The Ottawa District is half way between the equator and the north pole. It straddles the Ottawa River, the north half in Quebec and the south half in Ontario, and is centred on the cities of Ottawa in

Ontario and Hull in Quebec (Maps 1 and 2). The Ottawa District is defined as the area within the circle of 50 km radius centred on the Peace Tower of the Parliament Buildings in Ottawa (45°25'31"N,



MAP 1. Eastern Ontario and Western Quebec showing the Canadian Shield (shaded) and the St. Lawrence Lowlands (white). The Ottawa District is the area within the circle of 50 km radius centred on the Peace Tower in Ottawa. This map is adapted from an earlier version prepared by Joyce Reddoch and Marc Guertin (Reddoch 1983a).

75°42'03"W). It was established by The Ottawa Field-Naturalists' Club in 1895 (as a 30-mile circle; Anonymous 1895) as the common study area for all fields of natural history. During the century since then, many significant studies on the flora, fauna and geology of the District have been published by Ottawa Field-Naturalists' Club members, writing in their capacities as government scientists or as serious amateurs (Reddoch 1981a, 1981b, 1995).

In the mid 1960s, the Native Orchid Location Survey (see below) chose an Ottawa Study Area that

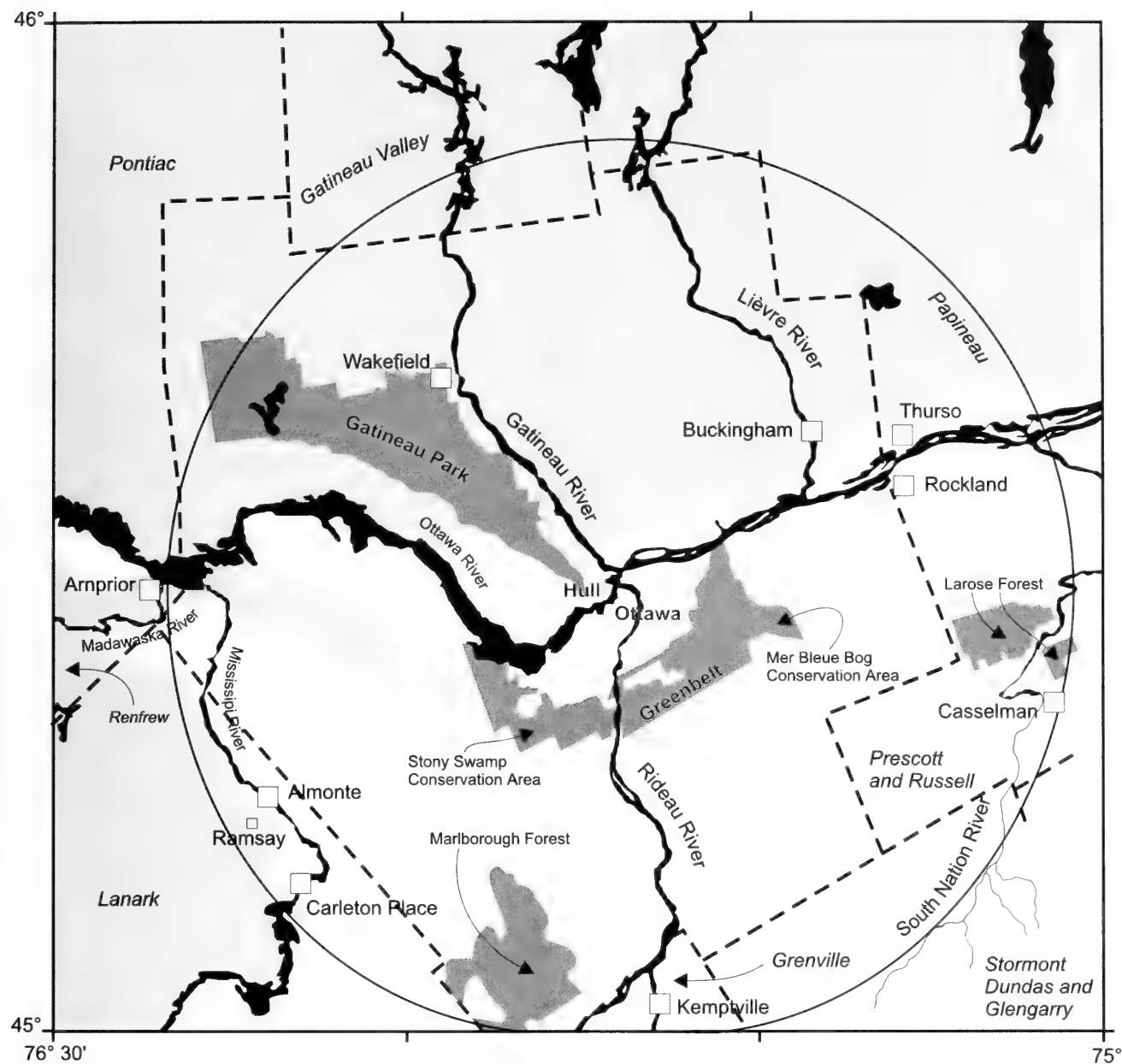
included the Ottawa District and all of the land within the rectangle between 45° and 46° N and 75° and 76°30' W (Map 2; Reddoch 1977b). The Ottawa Study Area (at 13 104 km²) is about 60% larger than the Ottawa District (at 7854 km²). Although the present work is concentrated on the Ottawa District, it includes, as well, information about the orchids in the surrounding Study Area. Although this surrounding area contributes useful information on habitats and colonies, no additional taxa except the acyanic form of *Cypripedium arietinum* have been found within it.

History of Orchid Collecting and Recording

The history of orchid studies in the Ottawa District is essentially that of the general flora, for only a few people have specialized in the study of the local orchids. In turn, the history of local botany is part of the history of Canadian botany, which has been described recently by Pringle (1995). (The plant lists mentioned below are summarized in Appendix 1.)

The earliest travellers, such as Samuel de Champlain in 1613, who was a good naturalist (Macnamara 1926), and the collector Philip Whiteside MacLagan in 1843 (MacLagan 1847; Dore 1983), mentioned only a few plant species in the District and did not report any orchids.

The first record of a local orchid is a painting by Elizabeth Keen White in 1856 of *Calypso bulbosa*



MAP 2. The Ottawa District and surrounding Study Area. The Quebec section of the District is dominated by the two Outaouais regional municipalities, la Communauté urbaine de l'Outaouais and les Collines-de-l'Outaouais, while the Ontario part is primarily in the Regional Municipality of Ottawa-Carleton. About a million people live in the District, three-quarters of them in Ontario.

collected at Ottawa by her husband William White, later the first president of The Ottawa Field-Naturalists' Club (Dore 1965*). Subsequently, she painted *Galearis spectabilis* in 1869, *Cypripedium parviflorum* in 1870 and *Goodyera repens* in 1877, as well as plants in other families. These paintings were based on local collections that apparently were not preserved.

The first orchid collections to survive were not made until two generations after the first settlements

around 1800. Several orchids — *Calopogon tuberosus*, *Liparis loeselii*, *Platanthera dilatata* and *Pogonia ophioglossoides* — were collected by Braddish Billings Jr. from Dow's Swamp near the Billings home in 1860 (specimens at Queen's University (QK)). In 1861, John Kerr McMorine (Ross 1984) began what was to become a large plant collection that by 1867 included 13 orchids from Ramsay, near Almonte, Ontario (QK and DAO; see Appendix 1). In that year, Braddish Billings Jr. (1867) published, in the Transactions of the Ottawa Natural History Society, a list of some 400 plants that he had collected in 1866 and 1867. This impressive list, almost one third of the Ottawa flora, contained eight orchid species, six of them new, bring-

An asterisk () after a date indicates unpublished item, listed separately in Documents Cited section between Acknowledgments and Literature Cited.

ing his total to ten species. Unfortunately, this collection, which James Fletcher (1888) had examined in the Museum of the Ottawa Literary and Scientific Society in 1888, has since disappeared.

In 1879, "fully forty gentlemen" founded The Ottawa Field-Naturalists' Club with "the express purpose of working up the natural history of the district" (Whyte 1880). Members of the Club, in particular James Fletcher and Robert B. Whyte, initiated a period of enthusiastic and productive field work that was to continue for some thirty years. Among the botanical collectors were Henry M. Ami, W. Hague Harrington, William Scott and H. Beaumont Small. In 1880, Fletcher published his *Flora Ottawaensis*, a list of 810 species that he had collected in 1879 within 12 miles of the city, including 25 currently recognized species of orchids. By 1888 he was able to begin publication of a much enlarged and annotated flora from within a circle of 30 miles radius. The number of orchids grew to 31 species (Fletcher 1893). (See Map 3 for early collecting sites.)

Four more species were discovered between 1893 and 1905. Between 1901 and 1911, John Macoun, who arrived in Ottawa in 1882, completed a manuscript on the Ottawa flora before moving to the west coast in 1912; however, it was never published (Macoun 1901, *circa* 1911*, 1979).

Starting about 1907, Charles Macnamara of Arnprior became the first person in the Ottawa Valley to devote special attention to orchids (Reddoch 1981c). He discovered and photographed, but apparently did not collect, 22 species (see Appendix 1). Much of his orchid work is summarized in an unpublished manuscript (Macnamara *circa* 1940*), although he did publish an early note (Macnamara 1911). (We found nine of his photographs filed with the orchid collections at the Smithsonian Institution (US).)

The period from 1912 to 1940 seems to have been fairly quiet as far as orchid collections are concerned; however, additional contributions were made by such people as Faith Fyles, Herbert Groh, M. O. Malte, A. E. Porsild, Frère Rolland-Germain and Frère Marie-Victorin. Only one new orchid species was discovered, the recently arrived *Epipactis helleborine* in 1930.

In the 1940s and 1950s, botanists at the Experimental Farm (Agriculture Canada) began an intensive program to strengthen the herbarium collections. Orchid sheets of this time bear the names of A. J. Breitung, J. A. Calder, W. J. Cody, W. G. Dore, J. M. Gillett, W. H. Minshall, D. B. O. Savile, H. A. Senn, J. H. Soper and M. N. Zinck. Some of these botanists were active from as early as the 1930s and as late as the 1970s and 1980s. Two new orchid species, *Platanthera lacera* and the then-undescribed *Spiranthes casei*, were discovered in the 1940s.

In 1950, some members of The Ottawa Field-Naturalists' Club, feeling the need to revive botani-

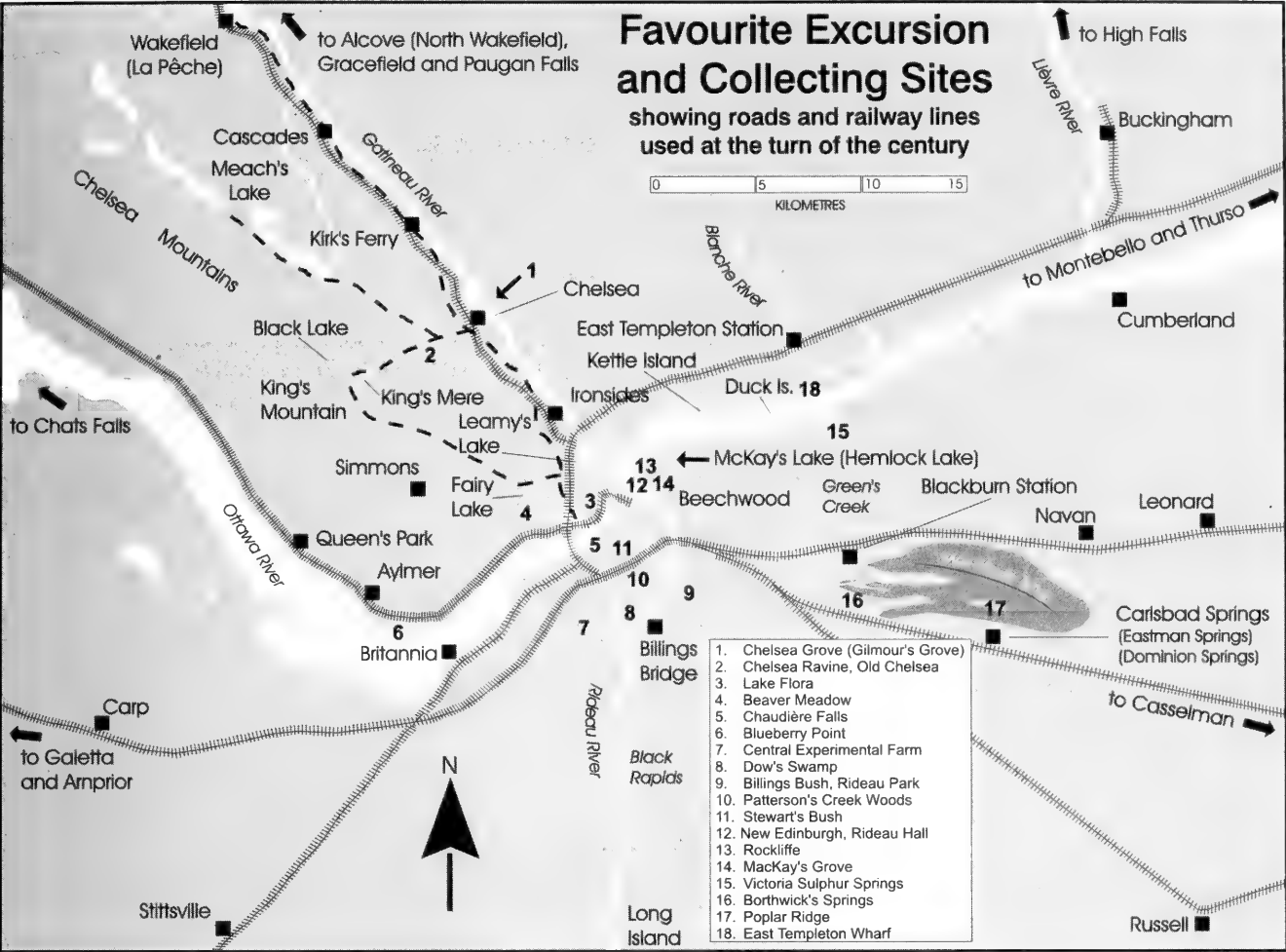
cal field work within the Club, formed the Fern Group. In 1955, the group wound up its study of ferns and expanded its activities under the name of Bog Group. Soon, this name seemed too restrictive and a new name, Traill Group (after Catharine Parr Traill, the Canadian pioneer and naturalist), was adopted along with a stated interest in orchids, among other subjects (Dill 1982). Orchid collectors in the 1950s and early 1960s included A. W. Anderson, I. Bayly, C. and E. Frankton, L. Jenkins and E. G. Ross.

In 1958, J. M. Gillett prepared the first new checklist of the Ottawa flora in over half a century. The total number of orchid species in the District was then 39 (including *Listera australis*, which had been inadvertently omitted from Gillett's list).

In the early 1960s, the arrival of E. W. Greenwood brought about the founding of the Club's Native Orchid Location Survey, which is discussed below. In 1977, J. M. Reddoch (1977b) published a list of the orchids of the District, which by then numbered 42 after the discoveries of *Listera auriculata* and *Platanthera leucophaea*, and with the description of *Spiranthes casei* as a new species. The following year, J. M. Gillett and D. J. White (1978) brought out a revised checklist of the Ottawa flora containing the same orchid species. In 1984, M. Runtz published an annotated list of the 30 species of orchids known in the Arnprior area, an increase of eight over Macnamara's treatment.

Beginning in the 1970s and continuing to the present, general floristic studies have declined in the District because of decreasing institutional support. In the 1970s and 1980s, members of the Conservation Committee of The Ottawa Field-Naturalists' Club were prompted by planning exercises at various government levels to identify and learn more about significant areas. Based on their research, they wrote briefs and published articles in The Ottawa Field-Naturalists' Club's local journal, *Trail & Landscape*. In the 1980s and 1990s, the National Capital Commission, the Ontario Ministry of Natural Resources and the Regional Municipality of Ottawa-Carleton contracted for more intensive surveying to evaluate candidate natural environment areas in their respective jurisdictions. These surveys generated a large number of valuable unpublished reports; collections made in support of these surveys were deposited in CAN and DAO. Among the collectors of orchids in the past 25 years are M. L. Anderson, S. G. Aitkin, D. F. Brunton, S. J. Darbyshire, A. W. Dugal, D. Gagnon, J. M. and A. H. Reddoch, M. J. Shchepanek, D. J. White and A. Vogt.

Now, in 1996, the number of orchids known in the Ottawa District has risen to 44 with the addition of two species that have been recognized anew, *Platanthera macrophylla* and *P. huronensis*, in a flora that totals about 1400 species.



MAP 3. Favourite Excursion and Collecting Sites a century ago. This map is adapted from a 1979 version prepared by Joyce Reddoch and Marc Guertin (Reddoch 1979b). Dashed lines show roads and lines with hatch marks show railways.

Native Orchid Location Survey

The arrival of Ed Greenwood in the Club brought a new level of enthusiasm, organization and knowledge to the study of Ottawa orchids, which led to the founding of the Club's Native Orchid Location Survey in 1966. Following the preliminary work of the Traill Group, the Survey set out to locate and map accurately the orchid colonies in the Ottawa District as well as in the rest of Canada (Greenwood 1967). Their goal was to make an inventory of the species present and their abundances for purposes of conservation, land-use planning and orchidological studies. After Ed left Ottawa in 1969, the position of Coordinator of the Survey passed to Hue MacKenzie, then to Bill Petrie in 1975, and finally to us in 1977.

The members of the Survey were mostly serious amateurs who were familiar with the current taxonomy and nomenclature. They reported the location of each orchid colony to within 100 m using the Universal Transverse Mercator Coordinates from National Topographic Maps. Varieties and forms were not recorded formally but were discussed among members.

Although the benefits of voucher specimens were recognized, they decided, in the interests of orchid conservation and minimization of the effort, not to make collections to document the many locations recorded, except for new species and special situations. Taxonomic revisions appeared that split new or reinstated species from the concepts being used by the Survey. These species, *Platanthera grandiflora*, *P. huronensis*, *P. macrophylla* and *Spiranthes casei*, were added to the Survey's list and all records for them were carefully verified. All of them have proved to be appreciably less abundant than the respective species from which they were split: *P. psycodes*, *P. hyperborea*, *P. orbiculata* and *S. cernua*. As far as possible, we reexamined sites that had already been recorded under the latter names to determine the correct identities. In some cases, reexamination was no longer possible but it is evident on a statistical basis that, given the relative scarcity of the species added to the list, these cases would contribute only a very few errors to the distribution maps of the more abundant taxa.

The accuracy of the location data also allowed us to monitor the progress of colonies and to correlate

plant locations with mapped soil and rock types. Thus the Survey data can be regarded as complementary to the herbarium collections in providing many more colony locations for each species. To safeguard the colonies, the detailed location data has been treated as confidential. Copies of the dataset have been deposited at the National Herbarium of Canada (CAN) and the Herbarium of Agriculture Canada (DAO).

After the first decade, the amount of new data being reported was declining as contributors moved on to new interests. We have continued to accept new reports to the present; however, we could not find the volunteers to carry on the project on a national scale. From its inception to the present, the Survey has collected some 3500 sight records for 43 species in the Ottawa Study Area with a total of 12 000 records for all of Canada.

Those contributing to the Survey in the District (and Study Area) during the first decade were R. Anstee, C. Appleton, D. F. Brunton, A. W. Dugal, A. J. Erskine, C. & E. Frankton, D. Gagnon, E. W. Greenwood, S. E. Hamill, A. Hanes, J. F. Keddie, J. D. Lafontaine, R. M. MacDonald, H. N. & E. MacKenzie, W. Petrie, A. H. & J. M. Reddoch, A. E. Richards, M. E. Stuart, E. C. D. Todd, D. J. White and R. E. Whiting. In addition to some of the above, the following provided records during the past two decades: B. T. Aniśkiewicz, E. Beaubien, R. A. Bracken, P. M. Catling, D. G. Cuddy, E. O. Dodson, M. Gawn, S. E. Godkin, F. E. Goodspeed, R. Killeen & S. Kettle, R. A. Layberry, M. H. S. Light & M. MacConaill, A. Mason, H. McLeod, T. Mosquin, P. J. Narraway, P. E. Rothschild, M. W. P. Runtz and A. Vogg.

The Orchids of the Ottawa District (following Dressler (1993))

CYPRIPEDIOIDEAE Lindley

- Cypripedium acaule* Aiton
- Cypripedium arietinum* R. Brown
- Cypripedium parviflorum* Salisbury
 - var. *pubescens* (Willdenow) Knight
 - var. *makasin* (Farwell) Sheviak
- Cypripedium reginae* Walter

SPIRANTHOIDEAE Dressler

CRANICHIDEAE Endlicher

GOODYERINAE Klotzsch

- Goodyera pubescens* (Willdenow) R. Brown in Aiton
- Goodyera repens* (Linnaeus) R. Brown in Aiton
 - var. *ophioides* Fernald
- Goodyera tessellata* Loddiges

SPIRANTHINAE Lindley

- Spiranthes casei* Catling & Cruise
 - var. *casei*
- Spiranthes cernua* (Linnaeus) L. C. M. Richard
- Spiranthes lacera* (Rafinesque) Rafinesque
 - var. *lacera*
- Spiranthes lucida* (H. H. Eaton) Ames
- Spiranthes romanzoffiana* Chamisso

ORCHIDOIDEAE

ORCHIDEAE

ORCHIDINAE

- Amerorchis rotundifolia* (Banks) Hultén
- Coeloglossum viride* (Linnaeus) Hartman
 - var. *virescens* (Muhlenberg) Luer
- Galearis spectabilis* (Linnaeus) Rafinesque
- Platanthera blephariglottis* (Willdenow) Lindley
 - var. *blephariglottis*
- Platanthera clavellata* (Michaux) Luer
 - var. *clavellata*
- Platanthera dilatata* (Pursh) Lindley ex Beck
 - var. *dilatata*

Platanthera flava (Linnaeus) Lindley
 var. *herbiola* (R. Brown) Luer
Platanthera grandiflora (Bigelow) Lindley
Platanthera hookeri (Torrey) Lindley
Platanthera huronensis (Nuttall) Lindley
Platanthera hyperborea (Linnaeus) Lindley
 var. *hyperborea*
Platanthera lacera (Michaux) G. Don in Sweet
 var. *lacera*
Platanthera leucophaea (Nuttall) Lindley
Platanthera macrophylla (Goldie) P. M. Brown
Platanthera obtusata (Banks ex Pursh) Lindley
Platanthera orbiculata (Pursh) Lindley
Platanthera psycodes (Linnaeus) Lindley

EPIDENDROIDEAE Lindley

NEOTTIEAE Lindley

LIMODORINAE Bentham

Epipactis helleborine (Linnaeus) Crantz

LISTERINAE Lindley

Listera auriculata Wiegand

Listera australis Lindley

Listera cordata (Linnaeus) R. Brown

 var. *cordata*

VANILLEAE Blume or other tribe

POGONIINAE Pfitzer

Pogonia ophioglossoides (Linnaeus) Jussieu

MALAXIDEAE Lindley

Liparis loeselii (Linnaeus) L. C. M. Richard

Malaxis monophylla (Linnaeus) Swartz

 var. *brachypoda* (Gray) Morris & Eames

Malaxis unifolia Michaux

CALYPSOEAE Dressler

Aplectrum hyemale (Muhlenberg ex Willdenow) Nuttall

Calypso bulbosa (Linnaeus) Oakes

 var. *americana* (R. Brown) Luer

Corallorhiza maculata (Rafinesque) Rafinesque

 var. *maculata*

 var. *occidentalis* (Lindley) Ames

Corallorhiza striata Lindley

Corallorhiza trifida Chatelain

ARETHUSEAE Lindley

ARETHUSINAE Lindley

Arethusa bulbosa Linnaeus

BLETIINAE Bentham

Calopogon tuberosus (Linnaeus) BSP.

Climate, Geology and Vegetation

Climate

The Ottawa District is a region of warm, moist summers and cold, snowy winters (data from Crowe 1984). In the centre of the District, the mean daily maximum and minimum July temperatures are 26.2°C and 14.8°C, while the corresponding January temperatures are -6.2°C and -15.1°C. Mean annual precipitation is 843 mm, while the mean precipitation of July alone is 86 mm. The mean frost free

period is 152 days, extending from, on average, 7 May to 7 October.

Although the above data give an average picture of the climate close to the Ottawa River, the weather is highly variable from day to day, month to month and year to year. The climate is influenced also by such factors as vegetation, elevation, water bodies and man-made features. On the whole, year-round precipitation is greater to the north and less to the south of

the Ottawa River, while temperatures are somewhat cooler to the north and warmer to the south.

Geology

The Ottawa District lies in two physiographic regions, the Canadian Shield and the St. Lawrence Lowlands (Maps 1 and 2; account derived mainly from Bélanger and Harrison (1980) and Chapman and Putnam (1984)).

The Canadian Shield forms the uplands of the north half of the District (and Study Area) and the western part of the Study Area, as well as the Carp Ridge. The bedrock belongs to the Grenville Province of the Precambrian Period. It is a complex of metamorphosed and igneous rocks of which the most common types are marble, quartzite, gneisses, granites and syenites. Much of the Shield is hilly with extensive areas of thin soils and exposed rock. Between the Ottawa and Gatineau Rivers, Gatineau Park occupies some of the highest land in the District, its position accentuated by the 130 to 250 m high Eardley Escarpment facing south over the Ottawa River valley. The Eardley Escarpment is the product of some of the faults that created and shaped the Lowlands of the Ottawa Valley in Paleozoic times.

The Lowlands are covered with thick, flat-lying layers of Paleozoic rock on top of Cambrian sandstone, which in turn lies on the basement Precambrian rocks. The Paleozoic rocks are mainly Ordovician limestones, dolomites, sandstones and shales.

Glacial deposits from the most recent (Wisconsinan) ice sheet are scattered across the District. Following the retreat of the ice sheet about 12 000 B. P., deep layers of clays and sands were deposited by the Champlain Sea, the marine inundation that covered the Lowlands, the lower parts of the Shield and far up the valleys of some northern rivers, especially the Gatineau. Sand and gravel beaches were left to mark successively lower water levels as the sea receded. Subsequent freshwater deposits of sands and clays were laid down by the ancestral Ottawa River in a broad swath adjacent to its present course, especially in the southeast.

Principal Orchid Habitats

The Ottawa District has a great diversity of land cover types, those of importance to orchids being forests, wetlands, shores and open areas. General descriptions of these types are given below; additional details are contained in the individual species accounts.

Forests

The forest vegetation in the Ottawa District is mainly deciduous or mixed with only a small proportion of coniferous forest. The moisture regimes of

Geological features that are particularly relevant to the distributions of some orchids in the Ottawa District are calcareous bedrock (marble and limestone), sandstone bedrock and sand deposits.

Vegetation

The Ottawa District lies in the Great Lakes - St. Lawrence Forest Region of Rowe (1972). This region is often combined with Rowe's Acadian Forest Region under the designation of Mixed Forest Region (*The Times Atlas of the World* (1975)). The Great Lakes Forest Region is defined by the overlapping ranges of Eastern White Pine (*Pinus strobus*), Red Pine (*Pinus resinosa*), Eastern Hemlock (*Tsuga canadensis*) and Yellow Birch (*Betula alleghaniensis*), while the Acadian Region is additionally characterized by Red Spruce (*Picea rubens*). All but Red Pine and Red Spruce are common in the District; these two are known mainly from the Shield, the latter only rarely. Other species characteristic of the Mixed Forest Region are also representative of the (Eastern) Deciduous Forest Region to the south and the Boreal Forest Region to the north; for example, Sugar Maple (*Acer saccharum*), Red Maple (*Acer rubrum*), Red Oak (*Quercus borealis*), Largetooth Aspen (*Populus grandidentata*) and White Elm (*Ulmus americana*) in the former, and White Spruce (*Picea glauca*), Black Spruce (*Picea mariana*), Balsam Fir (*Abies balsamea*), Trembling Aspen (*Populus tremuloides*), Balsam Poplar (*Populus balsamifera*) and White Birch (*Betula papyrifera*) in the latter.

There is a gradual tendency for the vegetation in the District to have an increasingly boreal component and decreasingly southern component towards the northern and western reaches; however, the continuous boreal forest does not begin for another 150 km or so north of the District (Rowe 1972).

Forests cover much of the Shield in the District but are confined to rocky or difficult locations in the mainly agricultural and urban Lowlands. According to Agriculture Canada's *Plant Hardiness Zones in Canada* map (1991), the Lowlands part of the District is in zone 5a and the Shield is in zone 4b.

forests suitable for most orchids are in the mesic to wet-mesic range. Much of the forest in the District is semi-mature (45 - 70 years old). There are only small pockets of forest over 75 years old.

Most forest-dwelling orchids in the District are found in mesic deciduous forests of semi-mature, shade-tolerant hardwoods with a composition approaching that of the climax deciduous forest in the region. Sugar Maple is the principal tree species; it is usually accompanied by a selection of other

deciduous trees including Beech (*Fagus grandifolia*), White Ash (*Fraxinus americana*), Hop Hornbeam (*Ostrya virginiana*), Basswood (*Tilia americana*), Red Maple, Yellow Birch and Black Cherry (*Prunus serotina*). These forests are often described as "rich" because they have a large diversity of plant species including many spring wildflowers. This diversity results from the abundance of humus and nutrients in the soil and the moderate amount of light still penetrating the tree canopy. There is even more light in and around forest edges and clearings that result from windfalls, cutting or rocky outcrops.

Mixed forests differ from deciduous forests by the addition of one or more of Eastern Hemlock, Eastern White Pine, Eastern White Cedar (*Thuja occidentalis*), White Spruce and Balsam Fir. Most of the orchids that grow in the deciduous forest are also found in the mixed forest. Some species more characteristic of coniferous forests are confined to coniferous groves in mixed forests.

Orchids characteristic of deciduous and mixed forests include *Coeloglossum viride*, *Corallorhiza maculata*, *C. striata*, *C. trifida*, *Cypripedium parviflorum* var. *pubescens*, *Epipactis helleborine*, *Galearis spectabilis*, *Goodyera pubescens*, *G. repens*, *G. tessellata*, *Platanthera hookeri*, *P. hyperborea*, *P. macrophylla* and *P. orbiculata*. *Aplectrum hyemale* is an extirpated species of this habitat.

Moist depressions and stream floodplains in mixed forests are important habitats for *Listera auriculata*, *Platanthera grandiflora* and *P. psycodes*. The Red Maple – Trembling Aspen – Yellow Birch forests with occasional conifers on the mesic to wet-mesic sand plains of the southeast are another important habitat for *Platanthera grandiflora*.

Coniferous forests are present in the District either as separate stands or as groves in otherwise deciduous forests. Forests of Eastern White Cedar, White Spruce, Eastern White Pine and Balsam Fir are common on the limestone plains of the Lowlands and on some parts of the Shield. Sandstone outcrops, Precambrian ridges and areas of sand are often covered with forests in which Eastern White Pine is dominant. The floors of coniferous forests are thickly carpeted with needles and are almost devoid of plants except for Wild Lily-of-the-valley (*Maianthemum canadense*), a few ferns and club-mosses, and certain orchids, including *Corallorhiza maculata*, *C. trifida*, *Cypripedium acaule*, *C. arietinum*, *Goodyera tessellata* and *Malaxis unifolia*.

Pine plantations on deep sand shelter a number of orchids. The Larose Forest, established in 1928 with extensive plantings of Red Pine, White Pine and White Spruce (Reid 1979), supports some large colonies of *Cypripedium acaule*, *Malaxis unifolia* and *Spiranthes lacera*, as well as a few *Corallorhiza trifida* and *S. romanzoffiana*. In addition, *Goodyera*

tesselata and *Platanthera hookeri* have appeared in similar plantations elsewhere in the District.

Wetlands

The three wetland classes that are important habitats for orchids in the Ottawa District are swamps, fens and bogs. About 60% of the local species grow in wetlands. The Canadian Wetland Classification System (Tarnocai 1988) defines these wetlands as follows:

"A *swamp* is a mineral wetland or a peatland with standing water or water gently flowing through pools or channels. The water table is usually at or near the surface. There is pronounced internal water movement from the margin or other mineral sources; hence the waters are rich in nutrients. If peat is present, it is mainly well-decomposed wood, underlain at times by sedge peat. ... The vegetation is characterized by a dense cover of deciduous or coniferous trees or shrubs, herbs, and some mosses."

"A *fen* is a peatland with the water table usually at or just above the surface. The waters are mainly nutrient-rich and minerotrophic from mineral soils. The dominant materials are moderately to well decomposed sedge and/or brown moss peat of variable thickness. ... The vegetation consists predominantly of sedges, grasses, reeds and brown mosses with some shrubs and, at times, a sparse tree layer."

"A *bog* is a peatland, generally with the water table at or near the surface. The bog surface, which may be raised or level with the surrounding terrain, is virtually unaffected by the nutrient-rich groundwaters from the surrounding mineral soils and is thus generally acid and low in nutrients. The dominant materials are weakly to moderately decomposed *Sphagnum* and woody peat, underlain at times by sedge peat. ... Bogs may be treed or treeless, and they are usually covered with *Sphagnum* spp. and ericaceous shrubs."

Swamps are scattered across the District, but they are especially abundant on the Lowlands. The most productive swamps from the point of view of orchids are calcareous and are characterized by various combinations of the following trees: Eastern White Cedar, Black Ash (*Fraxinus nigra*), Red Maple, Yellow Birch, White Spruce, Tamarack (*Larix laricina*) and Balsam Fir. The mesic to wet swamp floors are partially to heavily shaded; they are carpeted with rich layers of mosses interspersed with bare patches covered with fallen leaves. Cinnamon Fern (*Osmunda cinnamomea*), Foamflower (*Tiarella cordifolia*), Wild Sarsaparilla (*Aralia nudicaulis*), One-flowered Wintergreen (*Moneses uniflora*), Shinleaf (*Pyrola elliptica*) and Twinflower (*Linnaea borealis*) are some typical swamp plants. Characteristic orchids are *Corallorhiza trifida*, *Cypripedium parviflorum*, *C. reginae*, *Liparis loeselii*, *Malaxis monophylla*, *M. unifolia*, *Platanthera*

clavellata, *P. hyperborea*, *P. obtusata* and *P. psycodes*. *Corallorhiza striata*, *Cypripedium acaule*, *C. arietinum*, *Goodyera pubescens*, *G. repens*, *G. tessellata*, *Listera cordata*, *Platanthera huronensis* and *P. orbiculata* are occasionally found. *Calypso bulbosa* is a swamp-dweller that is rare in the District. *Liparis loeselii*, *Malaxis monophylla* and *Platanthera clavellata* are infrequent inhabitants of alder-willow swamps.

Fens are relatively uncommon in the Ottawa District; they are usually components of wetland complexes that include swamps and occasionally marshes (Reddoch 1983b). Calcareous sedge fens are the most significant fen type in the District. They are dominated by sedges (*Carex lasiocarpa* and sometimes *C. livida*) and typical fen mosses. Tamarack, Eastern White Cedar and Black Spruce occur in scattered clumps in some sedge fens and provide the tree layer in treed fens. (Treed fens are not well represented in the District; some sedge fens are rimmed by treed fen habitat.) The sedge fens are intermediate to rich fens with pHs in the range 6.0 to 7.0. (Poor fens (pH 4.6 - 5.5) are included under bogs below.) Six sedge fens rich in orchids have been studied in some detail (Reddoch 1979a, 1984, 1989). Four of the fens are underlain by limestone on the Lowlands in Ontario and two are underlain by marble on the Canadian Shield, one in Quebec and the other at the western edge of the Study Area in Ontario. See Appendix 2 for more details and a list of the plants recorded in these fens.

Two other important peatlands that contain swamp and fen habitats are the Leitrim Wetlands on the Lowlands (Dugal 1990, 1992, 1993) and Chilcott's Swamp on the Shield. Chilcott's Swamp, on the edge of Johnston Lake in Quebec, harbours at least 14 species of orchids. It was first explored by naturalists in 1892 (Whyte, Craig, and Cowley 1893) and has been visited from time to time since then (Fyles 1912; Anderson 1959; André Sabourin, personal communication 1992).

Dow's Swamp and Lake Flora are two Lowlands swamps, no longer extant, that likely contained pond-edge fens. Dow's Swamp (Reddoch 1978b; Illman 1980) was a peatland south of Dow's Lake in a depression that drained to the Rideau River, and Lake Flora was a 4-ha pond on l'Ile de Hull (Nagy 1974) that is now Parc Fontaine. Early naturalists recorded 13 orchids from Dow's Swamp and six from Lake Flora.

True bogs are uncommon in the District. The largest is the 25 km² Mer Bleue Bog, which, like Alfred Bog east of the District (Cuddy 1983), developed in undrained sections of channels abandoned by an ancestral Ottawa River. The Mer Bleue is a domed bog with peat up to 4 m deep. It is a mosaic of treed bog, shrub bog, poor fen and marsh, the result of natural development as well as of some impact from fires, logging, drainage projects, prac-

tice bombing and beaver dams. Black Spruce and Tamarack are the typical trees, with Grey Birch (*Betula populifolia*) in some open areas; Leatherleaf (*Chamaedaphne calyculata*) and Labrador Tea (*Ledum groenlandicum*) are the common shrubs. The Mer Bleue is the first place in Canada where *Listera australis* was found. This orchid is a species of the poor fen habitat, as is *Platanthera blephariglottis*, the other rare orchid in the Mer Bleue. In 1995 the peatland was accepted as the 33rd Canadian wetland in the Ramsar Convention on Wetlands of International Importance.

There are a number of small bogs and poor fens in the District. The bogs have developed in small depressions, while the poor fens usually take the form of sedge mats at the edges of lakes and ponds. *Cypripedium acaule* is the characteristic orchid of the true bog habitat; *Calopogon tuberosus* and *Pogonia ophioglossoides* are typical poor fen species, while *Arethusa bulbosa* occurs infrequently in this latter habitat.

Shores

Flooding, wave action and ice scraping along lakes and rivers maintain habitats suitable for a number of species, particularly *Platanthera flava*, *P. grandiflora*, *P. psycodes*, *Spiranthes cernua* and *S. lucida*. These orchids thrive in the moist alluvial soils with minimal competition. The *Platantheras* also grow in adjacent riparian forests of Red Maple, Silver Maple (*Acer saccharinum*), Red Ash (*Fraxinus pennsylvanica*) and other trees.

Other Open Areas

Expanses of exposed bedrock maintain suitable habitats for a number of orchids that grow in partial to full sun and can tolerate some dryness. *Cypripedium arietinum*, *C. parviflorum* var. *pubescens* and *Spiranthes lacera* are characteristic species of alvars, areas of thin soil over flat-lying limestone and marble (Catling and Brownell 1995). Over acidic rocks, *Cypripedium acaule*, *Malaxis unifolia* and *Spiranthes lacera* occur on Precambrian knolls and are joined by *Spiranthes casei* and *S. cernua* in areas of flat-lying, exposed sandstone. These naturally-occurring openings are sometimes enlarged by fires and blow-downs.

Ditches, borrow pits and abandoned fields are human creations that in the past century have provided new, although often transient, habitats for orchids that flourish in moist, exposed sites. Such habitats are colonized, sometimes in large numbers, by *Liparis loeselii*, *Platanthera lacera*, *P. psycodes* and *Spiranthes cernua*. Other species occasionally occurring are *Malaxis unifolia*, *Platanthera clavellata*, *P. grandiflora* and *S. casei* (rarely). Mowing, if done at the right time, maintains the habitat. Sandy stretches beside bogs have supported, in addition, *Calopogon tuberosus* and *Pogonia ophioglossoides*.

Local Distribution Patterns

Of the 44 species of Ottawa District orchids, all but five have been recorded on both the Canadian Shield and the St. Lawrence Lowlands within the District. The five exceptions are species that are rare or extirpated in the District: *Listera auriculata* and *Platanthera macrophylla* (on the Shield) and *Aplectrum hyemale*, *Listera australis* and *Platanthera leucophaea* (on the Lowlands). Eight other orchids occur predominantly on the Canadian Shield, while seven additional species are found mostly on the Lowlands.

The distributions of some orchids in the Ottawa District correlate with one or more of calcareous bedrock (marble and limestone), sandstone bedrock and sand deposits.

Marble is exposed or close to the surface especially in the western half of the Shield north of the Ottawa River and in the west of the Study Area, while limestone is close to or at the surface in the Lowlands on the limestone plain in the southwest and in various other locations. *Amerorchis rotundifolia*, *Arethusa*

bulbosa, *Calypso bulbosa*, *Corallorhiza striata*, *Cypripedium arietinum*, *C. parviflorum*, *C. reginae*, *Epipactis helleborine*, *Malaxis monophylla*, *Platanthera dilatata*, *P. flava*, *P. huronensis*, *P. leucophaea* and *Spiranthes lucida* have distributions that correlate with the occurrence of calcareous rock.

Thinly covered or exposed sandstone bedrock is present at some borders of the Canadian Shield, such as in the Stony Swamp Conservation Area, and also along a portion of the Gloucester Fault near South Gloucester. The distribution of *Spiranthes casei* correlates with the occurrence of sandstone on the Lowlands.

Important sand deposits occur in several areas of the Shield (Hoffman, Miller, and Wicklund 1967; Lajoie 1962, 1967; Bélanger and Harrison 1980) and on the Lowlands in the southeast (Wicklund and Richards 1962; Bélanger and Harrison 1980). *Liparis loeselii*, *Malaxis unifolia*, *Platanthera grandiflora*, *P. lacera* and *Spiranthes cernua* occur mainly on sand in the Ottawa District.

Continental Distribution Patterns

Continental distribution patterns of Ottawa District orchids fit roughly into the following North American biomes: Montane, Boreal, Mixed, (Eastern) Deciduous and Southeastern Coastal Plain Forest Regions, and Prairie. These biomes are mapped by Rowe (1972) for Canada and by Sheviak (1983) for the United States, with some inconsistencies between them.

The Ottawa District is in the Mixed Forest Region and, as might be expected, the majority of orchids (29 of 44) recorded here have their primary distribution in this Region.

Southern Affinities

A further five species are distributed both in the Mixed Forest Region and in the Deciduous Forest Region to the south. Four other species are predominantly inhabitants of the Deciduous Forest Region and they are near or at their northern limits here: *Aplectrum hyemale*, *Galearis spectabilis*, *Platanthera flava* var. *herbiola* and *Spiranthes cernua*. The distributions of four species, *Calopogon tuberosus*, *Corallorhiza maculata*, *C. striata* and *Malaxis unifolia*, reach various parts of Mexico, Central America and the West Indies (Luer 1975; Homoya 1993).

Northern Affinities

Ten species of the Mixed Forest Region also occur in the Boreal Forest Region to the north. Four additional orchids, *Amerorchis rotundifolia*, *Calypso bulbosa* var. *americana*, *Listera auriculata* and *Platanthera obtusata*, are mainly boreal species and they are near or at the southern edges of their distributions in the District.

Prairie and Coastal Affinities

Platanthera leucophaea and *Spiranthes cernua* are two species that also occur in the Prairie Region, while *Listera australis* is a representative of the Southeastern Coastal Plain Forest Region. *Calopogon tuberosus*, *Pogonia ophioglossoides* and *Spiranthes cernua* are other local species with important presences in the latter region.

European and Asian Affinities

Ten native Ottawa District species, most with northern affinities, also occur in Europe and/or Asia as the same or a different variety: *Calypso bulbosa*, *Coeloglossum viride*, *Corallorhiza trifida*, *Goodyera repens*, *Liparis loeselii*, *Listera cordata*, *Malaxis monophylla*, *Platanthera hyperborea*, *P. obtusata* and *Spiranthes romanzoffiana* (Luer 1975). In addition, *Epipactis helleborine* is a relatively recent arrival from Europe.

Rare Species

Of the 44 orchid species that have occurred in the Ottawa District, six have been designated as rare in Ontario, 13 as rare in Quebec and two as rare in Canada by The Rare and Endangered Plants Project of the Botany Division of the National Museum of Natural Sciences (Canadian Museum of Nature).

Ottawa District orchids designated rare in Ontario (Argus and White 1982) are *Aplectrum hyemale*, *Listera australis*, *Platanthera blephariglottis*, *P. grandiflora*, *P. leucophaea* and *P. macrophylla*.

Ottawa District orchids designated rare in Quebec (Bouchard et al. 1983) are *Aplectrum hyemale*, *Arethusa bulbosa*, *Corallorhiza striata*, *Cypripedium arietinum*, *C. reginae*, *Galearis spectabilis*, *Goodyera pubescens*, *Listera australis*, *Platanthera blephariglottis*, *P. flava*, *P. macrophylla*, *Spiranthes casei* and *S. lucida*.

Ottawa District orchids designated rare in Canada (Argus and Pryer 1990) are *Aplectrum hyemale* and *Platanthera leucophaea*.

These lists have provided a basis for the two provinces, Ontario and Quebec, to begin the process of determining what species of plants will be considered for legal protection. This process is on-going, but at present there is no specific legal protection for any of the District's vascular plants or their habitats

in either province. The species listed above for Quebec are recognized as "espèces de la flore vasculaire menacées ou vulnérables susceptibles d'être ainsi [par la loi] désignées" (Gazette officielle du Québec 1993; Brouillet 1994). Lists compiled by the Natural Heritage Information Centre of the Ontario Ministry of Natural Resources (Oldham 1996*) are released from time to time with further refinements of the status of species in Ontario.

Platanthera leucophaea is assigned the status of vulnerable in the 1996 list of The Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The current Government of Ontario has removed from consideration those species designated as vulnerable.

In the Ottawa District, all plants are protected on the property of the National Capital Commission (notably Gatineau Park and the Greenbelt) by the National Capital Act (Regulation #26).

Orchids that are rare or possibly extirpated in the Ottawa District are *Amerorchis rotundifolia*, *Aplectrum hyemale*, *Calypso bulbosa*, *Listera auriculata*, *L. australis*, *Platanthera blephariglottis*, *P. leucophaea* and *P. macrophylla*. All but *P. macrophylla* are at or near the limits of their distributions here.

The Need For Protection and Management

Orchids are one of the components of global biodiversity that are threatened by human activities. Loss of natural areas containing orchids causes the extirpation of populations and, bit by bit, could lead to the extinction of these species. To counteract these losses, we must ensure that large natural areas representing all significant local ecosystems are protected.

This paper contains many references to losses of orchid populations. Large scale human disturbance and destruction of the natural environment began in the last years of the 18th century with the establishment of the settlements beside the Ottawa River that grew into the cities of Ottawa and Hull, and by logging of the forests followed by conversion of suitable lands to agricultural use.

Most orchids have survived so far through the random accidents of being in places not yet accessible to or economically viable for destructive development. The establishment of large publicly-owned areas such as the Marlborough Forest, the Greenbelt and Gatineau Park has played a significant role in protecting some orchid populations. Although these areas were not set up primarily for the maintenance of biodiversity, their establishment was an essential first step in that direction. If that goal is to be achieved, it is imperative that protection of these reserves continue and be improved.

Current threats to orchids on private rural land include ongoing urban expansion, estate lot development (particularly in woodlands), limestone quarrying (including in alvars), logging, drainage of wetlands in anticipation of development and flooding of wetlands as a byproduct of building highways and access roads. There has also been some deliberate destruction of habitats by owners who do not want their hopes for development impeded by rare plants. Throughout the District, predation by White-tailed Deer (*Odocoileus virginianus*) and disruption of habitats by Beavers (*Castor canadensis*) have had some impact on orchid populations. A more serious threat is the encroachment of invasive plants on some of the area's most important habitats: wetlands are threatened by Glossy Buckthorn (*Rhamnus frangula*) and shorelines by Purple Loosestrife (*Lythrum salicaria*).

Because the interrelationships of the components of ecosystems are complex, the best way to protect orchids is to protect whole ecosystems. This requires the establishment of areas large enough to ensure that colonies lost to the natural processes of succession, fire and changes in drainage will be replaced in other suitable habitats nearby.

Management specifically for orchids usually will involve measures to maintain the habitat against

natural succession and water level disruptions. Managers will need as much information as possible on the life cycle of the orchids and on their habitat requirements. In addition, close monitoring of the colony and its habitat will be required along with cautious experimentation with remedial procedures when problems are detected and before the colony becomes too depleted. A remarkable local example of personal initiative in approaching such problems is Joe Purdon's 50-year management of a fen to enhance and maintain a population of *Cypripedium reginae* against encroachment by Eastern White Cedar and flooding by Beavers. This task has now been taken over by the Mississippi Valley Conservation Authority.

Colour Forms and Their Nomenclature

As with other characters, the intensities and hues of flower colours exhibit ranges, sometimes quite broad, that are characteristic of the species. Outside these normal ranges, more dramatic variations arise from specific genetic mutations. Some mutations disrupt biosynthetic pathways so that the plant becomes unable to produce an otherwise typical pigment. Other mutations interfere with the pattern control mechanisms that determine the distribution of pigment on the flower with the result that colour will appear in atypical parts of the flower or disappear from typical parts. A number of these variations have been found in the District (A. H. Reddoch and J. M. Reddoch 1987b).

It will be useful to review the general mechanisms responsible for these forms in terms of flower pigments and their colours. Most flower pigments belong to one of three classes of chemical compounds (Harborne 1982; Griesbach 1983; Harborne and Turner 1984; Arditti 1992). Colours ranging from purple through magenta to pink are usually produced by anthocyanins. Green is usually the result of chlorophyll, the primary photosynthetic agent of the leaves. Yellow may arise from a variety of classes of compounds, including anthocyanins, but most often from carotenoids. Carotenoids frequently occur with chlorophyll and also have a photosynthetic function. The presence of combinations of these pigments in a given flower can be demonstrated readily by simple chromatographic methods.

Within the typical colour range of a species, minor and sometimes major variation in intensity occurs. This is particularly noticeable for pink-flowered species such as *Arethusa bulbosa*, *Cypripedium acaule* and *Platanthera grandiflora*, but it can also be seen in some green or yellow flowers.

When two or more classes of pigments are present, intermediate colours arise that are characteristic of a given species. These colours can vary in hue as well

Regardless of the nature of the management, there will be a need for continuing monitoring by dedicated individuals. It is our experience that organizations often have poor corporate memories; the original information and objectives are sometimes lost. Sometimes instructions and precautions do not survive the chain of command from the conservation office to the operator of the cutter. The Ottawa Field-Naturalists' Club could take a role in such monitoring, although, ultimately, it will be enthusiastic and knowledgeable individuals who must do the job. It is encouraging that agencies on both sides of the Ottawa River employ competent and dedicated biologists to lay the groundwork for more enlightened conservation measures.

as in intensity from plant to plant with variations in the concentrations of these pigments. The resulting colours can be understood by the relatively complex theory of subtractive colour mixing (Billmeyer and Saltzman 1981), but it will be adequate to follow the artists' experience of the mixing of pigment colours. Mixing yellow and green produces a range of intermediate colours that occur in many of our greenish orchids. Yellow and magenta can yield brownish hues such as are seen in *Corallorhiza maculata* and sometimes in the sepals of *Cypripedium acaule*.

When equivalent amounts of the approximately complementary chlorophyll green and anthocyanin magenta are mixed, they yield a dark greyed colour of an intermediate hue. When the magenta dominates the mixture, the result is a darkened and greyed purplish colour. Such a colour can be found on the lower part of the lip of *Cypripedium arietinum* and frequently on the petals and sepals of *C. acaule*. If green is the dominant component, then the mixture will be a darker green with a reddish cast such as is sometimes found on the lower leaves and stem of *Epipactis helleborine*.

Absence of anthocyanin

This aberration is the most striking and familiar of the colour forms in the Ottawa District. Floral anthocyanin is absent occasionally in a wide range of plant species as a result of genetic mutations that disrupt the biosynthetic pathway for production of this pigment (Griesbach 1985). If no other pigments are normally present, then the result is a pure white, such as the lip of *Cypripedium acaule* f. *albiflorum* and the flowers of *Platanthera psycodes* f. *albiflora*. However, when a yellow pigment is also present, the loss of anthocyanin results in the yellow form seen in *Corallorhiza maculata* f. *flavida*. When both yellow and green pigments are also present, usually in moderate concentrations, they, together with the anthocyanin, combine to produce brown or greyish magenta. The absence of the anthocyanin then reveals a yellow-green colour as

in the sepals and petals of *Corallorhiza trifida* var. *verna*, *Cypripedium acaule* f. *albiflorum* and *C. arietinum* f. *albiflorum*.

This mutation causes the complete absence of anthocyanin so that the flower is pure white in the absence of other pigments or shows the colours of any other pigments present. A flower with a very small amount of anthocyanin may appear nearly white but evidently the plant's biosynthetic pathway for this pigment is intact. The pale colour lies near the limit of the normal range permitted by the control function. Thus the plant is not an albino. For example, plants of *Platanthera grandiflora* and *P. psychodes* with flowers so pale that the pink colour can be verified only by the boundary between the outer part of the lip and the pure white base are not f. *albiflora*.

It is known that some orchid species contain more than one anthocyanin pigment in their flowers (Arditti 1992). In such cases more complicated colour variations may arise if genetic mutations occur that affect the formation of only one of the pigments. It should be fairly straightforward to analyze the resulting colour changes.

Absence of chlorophyll

The absence of chlorophyll is another genetic defect, but is much rarer than the absence of anthocyanin mainly because most plants cannot develop to maturity without this essential photosynthetic agent (Furman and Trappe 1971). A few species, such as those of *Monotropa* and, among our orchids, of *Corallorhiza*, can develop normally with the aid of their associated mycorrhizae. In the District, two orchids normally bearing chlorophyll, *Epipactis helleborine* and *Platanthera hyperborea*, are known to have produced a few achlorophyllous plants. The colour of the plants was generally white although in some cases some small amounts of yellow could be seen in buds, leaves and stems. In *E. helleborine*, anthocyanins could be seen in the lip and the base of the stem, as is sometimes the case for normal plants.

Pattern variation

The occurrence of well-defined, reproducible genetic changes in the colour patterns of flowers is familiar in such well known plants as Snapdragon

(*Antirrhinum majus*) and Petunia (*Petunia hybrida*) and has proved useful in the study of gene expression (Fincham 1987; Jorgensen 1995). Among the orchids of the Ottawa District, *Galearis spectabilis* f. *willei* appears to show this effect. In this form, the magenta pigment of the sepals and petals extends to a greater or lesser extent over the normally white lip.

Nomenclature

Many colour variations have been given formal names, usually at the *forma* level. However, it is questionable whether these names are really a good method of communication. In the cases of distinctive, genetically based variations, it is usually possible to apply the names to well-defined entities. Nevertheless, it would be useful to refer to these plants by the mechanism involved, for example, acyanic, achlorophyllous or pattern variants, rather than by often obscure honorific or somewhat random descriptive names.

It is even more questionable to apply formal names to variations in hue or intensity that are within the normal variation of these characters. Even colours near the limits of the range are part of the normal expression of genetic or environmental conditions of the species. There is no natural boundary to separate such plants from their more typical relatives. Hence the creation of a variety or form for such plants requires an arbitrary designation of a boundary, a process that makes the variety or form itself arbitrary. There is the additional complication, in the case of colours, that the usual verbal descriptions of colour are not sufficiently unambiguous to define clearly such a boundary. A single type specimen could not designate a boundary even if its colour were stable. Formal names in these situations suggest a level of precision that is illusory; it would be more appropriate for most purposes simply to provide a concise, precise description. In this work, we generally do not use names that have been applied to plants with flower colours within the normal ranges for their species. In describing the flower colours of each species in the District, we include the full normal range and discuss special cases separately.

Blooming Periods

Table 1 summarizes the blooming dates of the orchids in the Ottawa District and Study Area. A related table was published previously (A. H. Reddoch and J. M. Reddoch 1987e). Similar charts for other areas in the northeast include those of Brown (1985) for the Bruce Peninsula, Ontario, Whiting and Catling (1986) for Ontario, Keenan (1987) for New England, Smith (1993) for Minnesota, and Homoya (1993) for Indiana.

Apparently split blooming periods of *Corallorhiza maculata*, *Platanthera dilatata* and *P.*

hyperborea (*sensu lato*) are shown for the Bruce. From our data for *C. maculata* in the Ottawa District, it seems likely that the split is related to the early and late blooming varieties, var. *occidentalis* and var. *maculata* respectively, although our overall set of dates for the District does not show the effect so clearly. On the other hand it seems unlikely that the split for *P. hyperborea* can be explained by the inclusion of *P. huronensis*, which have essentially the same blooming period in this region.

Blooming Periods of Ottawa District Orchids

SPECIES	MAY	JUN	JUL	AUG	SEP	OCT	#
Amerorchis rotundifolia							12
Arethusa bulbosa							41
Calopogon tuberosus							85
Calypso bulbosa							13
Coeloglossum viride							45
Corallorhiza maculata							56
Corallorhiza striata							29
Corallorhiza trifida							55
Cypripedium acaule							105
Cypripedium arietinum							48
Cypripedium parviflorum							142
Cypripedium reginae							64
Epipactis helleborine							80
Galearis spectabilis							72
Goodyera pubescens							20
Goodyera repens							19
Goodyera tessellata							36
Liparis loeselii							72
Listera auriculata							9
Listera australis							7
Listera cordata							14
Malaxis monophylla							38
Malaxis unifolia							105
Platanthera blephariglottis							21
Platanthera clavellata							28
Platanthera dilatata							40
Platanthera flava							16
Platanthera grandiflora							55
Platanthera hookeri							67
Platanthera huronensis							16
Platanthera hyperborea							85
Platanthera lacera							31
Platanthera leucophaea							10
Platanthera macrophylla							16
Platanthera obtusata							36
Platanthera orbiculata							41
Platanthera psycodes							121
Pogonia ophioglossoides							79
Spiranthes casei							42
Spiranthes cernua							125
Spiranthes lacera							82
Spiranthes lucida							19
Spiranthes romanzoffiana							33
	MAY	JUN	JUL	AUG	SEP	OCT	

TABLE 1. All data came from the Ottawa District except those for *Listera australis* and *Platanthera macrophylla*, which were supplemented by data from adjacent parts of eastern Ontario and western Quebec. The light bar shows the range and the heavy bar shows one standard deviation about the mean.

Capsules and Seeds

Capsules

Capsules of some Ottawa District orchids collected after seed release are illustrated in Figures 1a - d. These species were chosen to complement those shown by Homoya (1993) for Indiana, which are also representative of plants in the District except for *Spiranthes lacera*. The specimen of *Platanthera hyperborea* illustrated by Homoya is comparable to the mesic forest plant of the Ottawa District.

Sizes

Among species, the smallest capsules are those of *Listera cordata* at 0.3×0.2 cm and the largest are those of *Cypripedium reginae* at 3.6×1.2 cm.

Colours

Generally, at the time of seed release, capsule colours are in the range of grey-brown through light to dark brown. Sometimes there is a tendency to blackening. At the same stage, *Epipactis helleborine* capsules may occasionally still be partially green. A few species have quite light-coloured capsules: *Liparis loeselii*, *Malaxis monophylla*, *M. unifolia* and, most notably, *Listera cordata*. The latter species is also notable for its early seed release, which can occur even when the flower is still fresh-looking and the capsule is still green.

Orientation

The capsules of most species are erect or ascending, but those of the Corallorhizas and sometimes of *Epipactis helleborine* are pendent. Capsule orientation appears to be determined by gravity rather than by the orientation of the inflorescence axis. We have seen examples in the field of *Pogonia ophioglossoides* and *Platanthera macrophylla* where the stem had been accidentally leaning at an angle during and after capsule development. In these cases, the capsule orientation was distinctly vertical rather than erect (parallel to the stem). Presumably this can happen in other species also.

For most species, the dried-up remnants of the flower remain attached to the end of the capsule, sometimes conspicuously so as in the larger *Cypripediums*. In *Calopogon tuberosus* and *Arethusa bulbosa*, however, the column is the most distinctive remnant. Often for *Pogonia ophioglossoides*, the entire flower disappears, apparently by dehiscence.

Capsule Yields

The yield (the fraction of flowers producing capsules) for individual plants tends to be highly variable and the data somewhat limited, but patterns emerge for some species. The uncommon orchid *Arethusa bulbosa* has very low yields, of the order of a few percent. At the other end of the scale, *Spiranthes cernua* and *S. casei*, both reported to be

autogamous (Catling and Catling 1991), regularly approach 100% yields. A third group of species tends to have rather random yields but with an appreciable number of plants approaching 100% yields. This group includes *Coeloglossum viride*, *Epipactis helleborine*, *Platanthera clavellata* and *P. hyperborea*, all of which are reported to be autogamous (Catling 1983a; Catling and Catling 1991), at least in some parts of their ranges. *Corallorhiza maculata* and *Spiranthes lacera* usually have yields over 50%, the first of these also being reported as being autogamous (Catling 1983a; Catling and Catling 1991). *Goodyera pubescens* seems unique in having either very high or very low yields.

For *Arethusa bulbosa* and *Listera cordata* our limited results are similar to those reported elsewhere; however, for *Calopogon tuberosus*, *Cypripedium acaule*, *Galearis spectabilis* and *Pogonia ophioglossoides*, our estimates of Ottawa District yields are appreciably higher.

Seeds

Seeds have much the same range of colours as the capsules and there is some rough correlation between the colours of the seeds and of the capsules they come from. The darkest seeds tend to occur in some of the *Platanthera* species, particularly in the section *Blephariglottis*. The seed studies of Arditti, Michaud, and Healey (1979, 1980) and Healey, Michaud, and Arditti (1980) show a level of colour variability comparable to what we find for capsule colours and, with more limited data, for seeds. Their seed colours are similar to ours in some cases, in others they are somewhat darker. Some of these differences could reflect terminological differences between their "subjective" colour names and the *Methuen Handbook of Colour* names (Kornerup and Wanscher 1978) used here. We find a moderate level of correlation between our colour observations and the levels of pigmentation reported by Stoutamire (1983).

For most species, seed release begins between September and mid October, after the capsules have changed colour. Exceptional species that release seeds earlier are *Listera cordata*, *Epipactis helleborine*, *Platanthera dilatata* and *Spiranthes lacera*. The late blooming *S. casei* and *S. cernua* tend to release their seed in the latter half of October. These observations are consistent with those of Stoutamire (1964) for species in the upper Great Lakes region.

Knowledge of seed release times may be useful for management purposes, for example, to avoid mowing before most of the seeds have been released.



FIGURE 1a. Capsules after seed dispersal (left to right, upper row): *Amerorchis rotundifolia*, *Corallorhiza striata* and *C. trifida*; (lower row): *Cypripedium arietinum*, *Goodyera repens* var. *ophioides* and *G. tessellata*; approximately life size.



FIGURE 1b. Capsules after seed dispersal (left to right): *Listera cordata* var. *cordata*, *Malaxis monophylla* var. *brachypoda*, *Platanthera blephariglottis* var. *blephariglottis* and *P. dilatata* var. *dilatata*, approximately life size.



FIGURE 1c. Capsules after seed dispersal (left to right): *Platanthera grandiflora*, *P. huronensis* and *P. leucophaea*, approximately life size.



FIGURE 1d. Capsules after seed dispersal (left to right): *Platanthera macrophylla* (scale bar = 5 cm), *P. obtusata*, *Spiranthes casei* and *S. lacera* var. *lacera*, the latter three approximately life size.

Overwintering States

Orchids in the Ottawa District are dormant for half the year, thus it is worthwhile to describe the state in which they spend half their time. Most District orchid plants re-create themselves every year. Notable exceptions are the Cypripediums, which rise from annual extensions of long-lived perennial rhizomes, the Goodyeras, which produce flowering stems from creeping rhizomes on a cycle several years long, and the Corallorhizas, which produce flowering stems annually or at intervals of several years from coralloid root systems.

Most species with fibrous, fleshy or tuberous roots begin producing the shoots for next year's plants at flowering time or even before. Shoots develop at the bases of the current year's stems or a few centimetres away on horizontal roots or other structures. Except for some late-blooming *Spiranthes*, new roots also

form and begin to elongate before dormancy. Most plants overwinter with the green shoots projecting just above the ground surface beside the brown remains of the current year's stems, while the shoots on some species remain just below the ground or moss surface until spring. Currah, Smreciu, and Hambleton (1990) illustrate the seasonal development of mycorrhizal roots and tubers of *Coeloglossum viride*, *Platanthera hyperborea* (*sensu lato*), *P. obtusata* and *P. orbiculata* in Alberta. Although plants produce new shoots, these shoots may die in the spring, followed during the summer by the roots.

In orchids growing from corms, the new corms begin to develop in the spring and mature during the summer. These orchids overwinter as the mature corms, from which they produce new stems the following year.

Longevity of Colonies

Some orchid plants and their colonies are short-lived even in habitats that appear not to change. Other orchid colonies are transient because their specialized habitats change. However, most species that live in stable environments may persist many decades, either because individual plants are long-lived or because reproduction is consistent and abun-

dant. In fact, the three decades during which we have monitored colonies can be only a short segment of the life of some orchid colonies.

In forests, colonies may be almost as old as their forest habitats, typically to about 65 - 70 years in the District, whereas in stable peatlands, colonies may be several hundred years old.

Variability of Characters

All characters show a range of sizes or values reflecting genetic or environmental influences. The ratio of the standard deviation to the average provides a convenient measure of such variation. For heights, this ratio is between 18% and 33% for most of our species. However, *Platanthera hyperborea* is notable for its ratio of 50%. *Liparis loeselii* and *Epipactis helleborine* are the next most variable species with ratios of 36% and 37% respectively. For the first two species much of the variation may be

attributed to adaptation to different habitats, which is discussed in the individual species accounts following. For *E. helleborine* no specific cause is evident, although the species is often regarded as being quite variable.

For the number of flowers, these three species again show great variability with ratios of 69%, 61% and 67% respectively. However the largest ratio, 70%, comes from *Platanthera huronensis*. For other orchid species, the ratio runs from 25% to 56%.

Methodology

The species descriptions are based on our observations made in the field in the Ottawa District and the surrounding Study Area since 1966 and on herbarium specimens from the same areas examined at the following institutions (listed in *Index Herbariorum Part I* (Eighth Edition)): Canadian Museum of Nature (CAN), Carleton University (CCO), Agriculture Canada (DAO), Field Museum of Natural History (F), Royal Botanical Gardens (HAM), Université de Montréal (MT), McGill University (MTMG), U.S. National Arboretum (NA), Canadian Forestry Service (OTF; now incorporated in CAN), Queen's University at Kingston (QK), Royal Ontario Museum (TRT) and Smithsonian Institution (US). In a few cases information from nearby surrounding regions is included and identified as such. The descriptions also include information from the following publications of The Ottawa Field-Naturalists' Club: *Transactions of the Ottawa Field-Naturalists' Club* (1879 - 1887), *The Ottawa Naturalist* (1887 - 1919), *The Canadian Field-Naturalist* (1919 - present) and *Trail & Landscape* (1967 - present), as well as *Transactions of the Ottawa Natural History Society* (1867 - 1869).

Our orchid specimens and photographs of rare taxa made during the course of this study have been deposited in CAN and DAO; mosses have been deposited in CANM.

ENGLISH NAMES: These names come mainly from Whiting and Catling (1986). We rejected names that gave erroneous impressions, for example, Tall White Bog-orchid for *Platanthera dilatata* because this species does not grow in bogs, and any name for *P. macrophylla* that implies, incorrectly, that this species has exceptionally large leaves or leaves larger than *P. orbiculata*.

FRENCH NAMES: We have taken the French names from Sabourin (1993), Argus and White (1982) and Fleurbec (1994*), transferring names from Habénaire to Platanthère where necessary. For *Platanthera macrophylla* we propose a name related to the English name that satisfies the objectives stated above.

SYNONYMS: Names in this section are those used in the (mostly older) Ottawa District and other literature and are not a complete synonymy. Some authorities cited in the older literature have been amended to current usage.

INTRODUCTION: Each species is introduced with a comment on notable features followed by field characters that distinguish it from other species in the same genus or from similar orchids in the same habitat.

PLANT DESCRIPTIONS: Plant descriptions are confined to heights, flower numbers and colours, numbers of leaves, overwintering states, capsules and

seeds. These characters were chosen because they allowed a more quantitative account or were otherwise of interest to us. Other aspects are well covered by recent publications (for example: Smith 1993; Homoya 1993).

Heights: The heights are based on our measurements of herbarium specimens and plants in the field. The full range is reported along with the range including one standard deviation about the mean. See Numerical Results below.

Flowers: The numbers of flowers were obtained from herbarium specimens and our field counts. For multiflowered species the full range is reported along with the range including one standard deviation about the mean. (See Numerical Results below.)

To have a standardized terminology for the colour names of flowers, leaves, capsules and seeds, we have used those in the *Methuen Handbook of Colour* (Kornerup and Wanscher 1978). This book has a reasonably convenient format for field work and, with 1266 colours, it permits fairly subtle distinctions for reporting colour variation through the use of its alphanumeric notation. In this work, we are concerned with broader ranges and hence report the colours by the more general (and more familiar) English names given in the Handbook. (Two areas where these names are too broad are the rather extensive ranges described as greyish green and greyish magenta.) Standardized nomenclature is especially helpful for colours in the pink-purple-rose group and for reporting the darker greens of the leaves of the *Goodyeras*. Although *Goodyera* leaves, as well as those of *Cypripedium arietinum*, have sometimes been described as bluish green, no examples that we have seen conform to the use of that term in the Handbook, the Centroid colour system (National Bureau of Standards s.d.; Kelly and Judd (1976)) or The RHS Colour Chart (1966). Greyish green or dark green are the Handbook names that we have found appropriate.

The sense of smell seems to be both more complex and less understood than the sense of colour vision. Orchid fragrances may be the product of as many as 50 different compounds in a wide range of concentrations (Arditti 1992) while human sensitivity is extremely variable in its ability to detect these compounds. The intensity and composition of these fragrances, which presumably are used primarily to attract and perhaps to guide insect pollinators, can be strongly dependent on the time of day and probably other factors such as temperature. Hence it is difficult to achieve precise and concise descriptions of such fragrances.

The fragrances reported here are our subjective description of our field experience. Joyce is notably

more sensitive than Allan, who is consistently unable to detect odours from some species such as *Corallorhiza maculata*. Such failures are not included in the accounts. Joyce's mother, Florence Dunston, provided an expert second opinion on occasion.

Leaf or Leaves: The numbers of leaves of flowering plants were obtained from herbarium specimens and our field counts. For multi-leaved species the maximum range observed is reported. When this range seems unusually large, we also report a smaller, more typical range. Counts for non-flowering plants are reported separately when available. In some cases, other leaf characteristics such as orientation and colour are recorded.

Overwintering State: We report the dormant condition of the shoot or bud as observed above ground or within the moss substrate in the autumn, having taken care not to injure the plants. We obtained some evidence of the condition at anthesis from herbarium specimens.

Capsules: We describe the condition of the capsules in the autumn.

Sizes: We measured small samples of capsules for each species and cite the averages as a general impression of size.

Yields: We report yields derived from relatively small samples taken on a casual basis at various locations over the past 15 years. For single-flowered plants the yield is the ratio of the number of capsules to the number of flowers in the sample and for multi-flowered plants it is the average of such ratios for the individual plants in the sample. Where several sites were studied, sometimes over several years, it was possible to report on the variability of the yields.

Seeds: The colours of the seeds represent a small sampling which may not adequately reveal the range of variation in some species. The colours describe a small pile of seeds rather than a single seed. Under a microscope, it can be seen that the colour is sometimes determined by the embryo and sometimes by the testa or a part thereof.

We derived the first dates of seed release from our records of dates when one or more capsules were observed to be open in various colonies and years. These individual dates for each species are spread over a period of a week to 10 days and hence, in the species accounts, are summarized as being in the early, mid or late part of the month. If our records did not also include dates when no capsules were open, then we report that capsules were open "by" a particular time. Presumably various factors including weather, habitat, genetics and the frequency of our visits contribute to the spread of our data.

BLOOMING PERIOD: These results are based on herbarium collections and our field records. The

only literature reference is for *Arethusa bulbosa* and *Listera australis*, for which the early date of 28 May reported by Fletcher (1896) is included. The results are summarized in Table 1. The same ranges are given in the species accounts. See Numerical Results below.

COLONY SIZES: These results are from the Native Orchid Location Survey and our field records. A colony is taken to include all plants seen at a given UTM coordinate, that is, in an area 100 m by 100 m. The minimum (usually one) and maximum numbers of plants are given and, in some cases, a smaller, more typical upper limit. See Numerical Results below.

CURRENT STATUS: This topic is included when a species is rare in the Ottawa District, Quebec, Ontario or Canada, or is very abundant. Gillett and White (1978) included the status of Ottawa District species based on herbarium specimens.

DISTRIBUTION: General North American distributions are included to give impressions of where the Ottawa District lies within them. They come mainly from Homoya (1993) but also from Smith (1993), Luer (1975) and specialist papers cited in individual species accounts. Distribution patterns in the District are summarized briefly with regard to the Canadian Shield and the St. Lawrence Lowlands and with emphasis on significant correlations with relevant bedrock and surficial geological features.

DISTRIBUTION MAPS: The maps include all plottable records from as early as 1860 to the end of the 1996 field season (up to 137 years). Thus they show the cumulative occurrences of each species and not necessarily its current status.

The distribution data derive from three sources: herbarium specimens, additional sight records from the Native Orchid Location Survey (1965 - 1996) and literature references in the *Transactions of the Ottawa Field-Naturalists' Club*, *The Ottawa Naturalist* and the typescripts of John Macoun (circa 1911*) and Charles Macnamara (circa 1940*). Locations cited on herbarium specimens except those from the last couple of decades are often described rather generally and therefore cannot be plotted very accurately. The many early specimens from locations cited only as "Ottawa", "Hull", "swamp, Ottawa", "environs d'Ottawa" and similar forms could not be plotted at all. By contrast, the 3500 records generated by the Native Orchid Location Survey give the location of each colony to within 100 m.

Major occurrences of calcareous bedrock (marble on the Shield and limestone on the Lowlands), sandstone bedrock (Nepean and March Formations) and sand deposits on the Lowlands are shown for those species where there are strong correlations with orchid occurrences. Although limestone is widespread on the Lowlands, it is deeply covered by

overburden in many places, especially in the south-east. The Canadian Shield is shown on most maps. The information is derived from a number of local geological maps (Geological Survey of Canada 1912, 1973, 1974, 1977; Wicklund and Richards 1962; Hogarth 1970; Bélanger and Harrison 1980).

The distribution maps were initiated by Ed Greenwood and were updated by successive Native Orchid Location Survey coordinators; Joyce Reddoch and Marc Guertin produced the base map and the geological overlays.

HABITATS: The descriptions are specific to the Ottawa District and are derived from our own observations and from herbarium labels. Most names of vascular plants and the order in which they are listed are from Gillett and White (1978).

LONG-LIVED COLONIES: Under this heading we report our observations of colonies that we have monitored for from one to three decades. These treatments contribute additional details of habitats for specific sites.

EARLY HISTORY: The first known collection and other early collections are emphasized; the complete known history is related for recently-discovered species. John Kerr McMorine's collections, Braddish Billings Jr.'s list (1867), James Fletcher's lists (1880, 1893), John Macoun's list (*circa* 1911*) and Charles Macnamara's illustrated typescript (*circa* 1940*) are referred to where relevant. (See also Appendix 1.)

SPECIAL TOPICS: Topics treated include accounts of colour forms, morphological variation with habitat, aberrations, exceptional plants, seasonal development, vegetative reproduction, dermatitis and further diagnostic notes.

FIGURES: The illustrations were prepared by Susan Laurie-Bourque from our photographs and drawings,

and from fresh flowers. They show living plants that are typical of this area. All of the plants depicted grew in the District or Study Area except *Amerorchis rotundifolia* (Frontenac County), *Calypso bulbosa* (Frontenac County) and *Listera australis* (Alfred Bog). Habitat, location and date are given for each subject.

NUMERICAL RESULTS: Dates and measurements are reported in the form a (b - c) d, where a and d are the upper and lower limits and b and c represent one standard deviation below and above the average, respectively. While various authors report only a and d, these values refer only to the most unusual members of the species. The range b - c describes the more normal plants and, for a normal distribution, includes 68% of the population. Some caution is required in the more detailed application of the standard deviation because the data for blooming dates, flower counts and plant heights frequently deviate from the normal distribution. These deviations often reflect a slight excess of late dates or large heights or flower counts. In the case of the heights and counts, such asymmetric distributions are not surprising for quantities that have large fractional variation but cannot be negative.

By contrast distributions of colony sizes are not even approximately normal because most species have colonies containing only a few plants while large colonies can occur but are infrequent. For this reason the full range is given and, when 15 or more records are available, a statement "typically to" is included indicating an upper limit that includes 95% of the colonies. This value was obtained simply by excluding 5% of the colonies at the upper end of the range.

In *Spiranthes cernua*, where some results are given mainly for purposes of comparison, an average value is given followed by the standard deviation in brackets.

Amerorchis rotundifolia (Banks) Hultén

Small Round-leaved Orchis

Orchis à feuille ronde

SYNONYMS: *Orchis rotundifolia* Banks, *Habenaria rotundifolia* (Banks) Richardson

Amerorchis rotundifolia is an attractive but rare fen orchid, apparently approaching extirpation in the District. The only currently known colony produces few and often no flowering plants. This species can be recognized by its single, basal, elliptical, somewhat pointed leaf and by its irregular inflorescence of purple and white flowers with three-lobed lips.

DESCRIPTION

Height: 9 (15 - 24) 26 cm [25 plants].

Flowers: 1 (3 - 9) 17 [29 plants]; dorsal sepal pale violet outside, white with similarly coloured markings inside; lateral sepals white, sometimes with a pale violet stripe on both surfaces; petals purple, or greyish magenta or light lilac edged with purple; lip white with purple, purplish red or deep magenta spots or larger markings (see Colour Pattern Variant below) and yellowish green or paler colour at entrance to spur; spur white; column similar in colour to petals; ovary light green with colour similar to dorsal sepal distally as stripes or solid colour; in a loose, irregular, somewhat one-sided inflorescence; no fragrance detected.

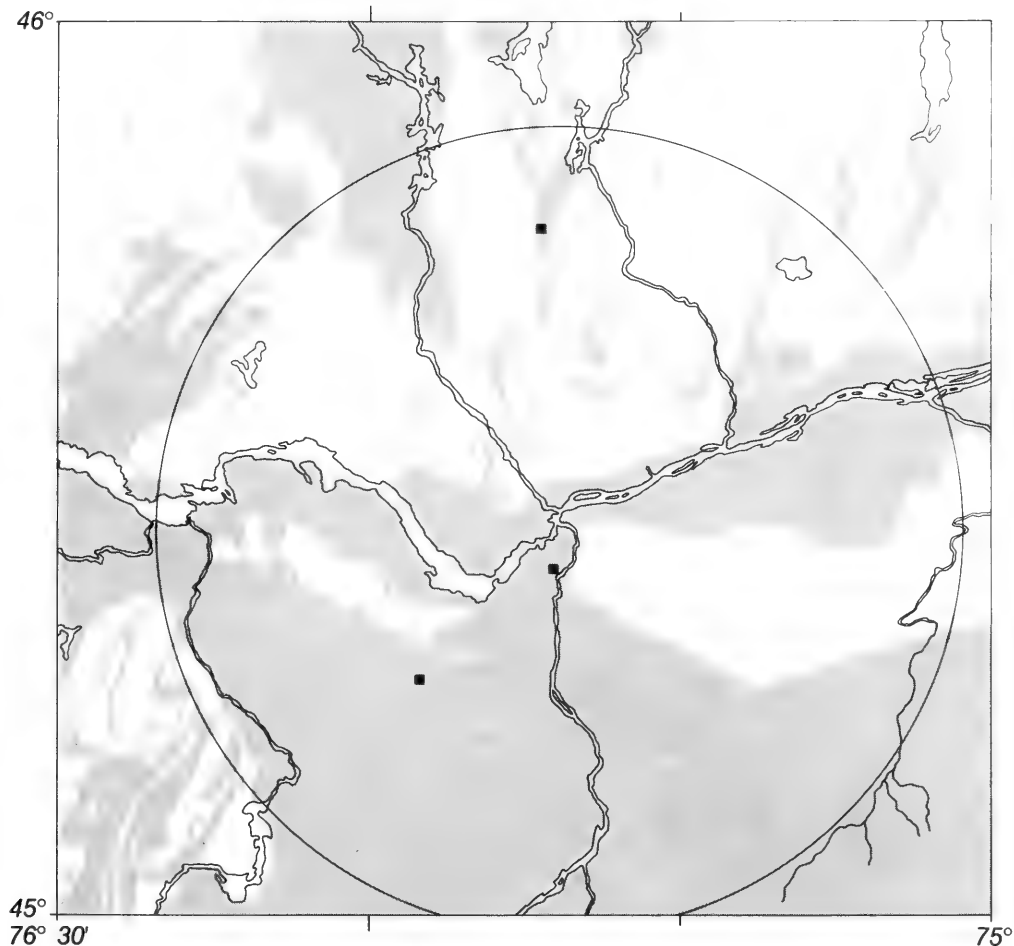
Leaf: 1; 1 on non-flowering plants.

Overwintering State: a whitish green shoot about 1 cm long, within the moss substrate, rising from a horizontal rhizome several centimetres away from the current year's stem, by early fall; herbarium specimens show the new shoot and partially elongated roots present at anthesis.

Capsules: dark brown, narrowly ellipsoid, typically 1.2 x 0.4 cm, erect (see Figure 1a); yield highly variable, averaging 45% [32 plants].

Seeds: brown, released in late September.

BLOOMING PERIOD: 10 June (19 June - 5 July) 12 July [12 records].



Amerorchis rotundifolia: ■ = herbarium specimen. Major areas underlain by calcareous rock (marble and limestone) are shaded.



FIGURE 2. *Amerorchis rotundifolia*, treed fen habitat, Palmerston Township, Frontenac County, Ontario, 1 July 1972 (plant and flowers), 19 June 1996 (column); for the column (front view), scale bar = 0.5 mm.

COLONY SIZE: 0 - 12 flowering plants, between 1967 and the present, at the only extant colony in the District; as loose groups of flowering and non-flowering plants in larger colonies in Eastern Ontario.

CURRENT STATUS: rare and local in the Ottawa District; one colony known to be extant, but close to extirpation.

DISTRIBUTION: The Ottawa District is near the southern edge of the distribution of this orchid of the Boreal Forest Region (Catling 1983b). Within the District, only three calcareous fens are known to have harboured this orchid (J. M. Reddoch and A. H. Reddoch 1987a). The nearest known colonies outside the District are 100 km southwest of Ottawa in Frontenac County and 100 km northwest near Westmeath in Renfrew County. This species is confined to treed and open fens in regions of calcareous bedrock.

HABITATS: This orchid grows in fairly open treed fens, open sedge fens and some swamps associated with these fens.

In treed fens and swamps, Black Spruce, Tamarack, Eastern White Cedar and Balsam Fir are the dominant trees; saplings of the latter two species constitute the understory. Labrador Tea (*Ledum groenlandicum*) is the most common shrub, and *Carex paupercula*, *C. stricta*, *C. trisperma*, *Eriophorum viride-carinatum*, Three-leaved False Solomon's Seal (*Smilacina trifolia*), *Cypripedium parviflorum*, *C. reginae*, *Platanthera huronensis*, Pink Pyrola (*Pyrola asarifolia*) and Twinflower (*Linnaea borealis*) are common herbaceous plants. The peatland floors are extensively covered with mosses, especially Sphagna. Within these treed habitats, *A. rotundifolia* plants, flowering and non-flowering, are grouped in well-defined open areas where the canopy is thin or somewhat open and the shrub layer is absent. They are usually growing in mounds of wet Sphagna, including *S. russowii* (pH 6.3 in the treed fen near Poltimore (J. M. Reddoch and A. H. Reddoch 1987a)). In 1996, we recorded a temperature of 14.5C at the root level at anthesis in the colonies near Poltimore and in Frontenac County.

In a swamp dominated by Eastern White Cedar near Westmeath, the herbaceous layer also included Shining Clubmoss (*Lycopodium lucidulum*), Dwarf Scouring-rush (*Equisetum scirpoides*), Rattlesnake Fern (*Botrychium virginianum*), *Carex leptalea*, Goldthread (*Coptis trifolia*), *Viola* spp., Spikenard (*Aralia racemosa*), One-flowered Wintergreen (*Moneses uniflora*) and Canada Fly-honeysuckle (*Lonicera canadensis*), as well as the additional orchids *Corallorhiza trifida*, *Liparis loeselii*, *Listera cordata*, *Malaxis monophylla* and *Platanthera obtusata*.

In sedge fens, plants of *A. rotundifolia* are scattered across the open fen, both on mounds of fen mosses and in the wet peat of the fen floor.

LONG-LIVED COLONIES: Ed Greenwood discovered the only currently extant colony near Poltimore in 1966. The 12 plants were situated in a swamp habitat that was near the outside edge of a peatland composed mainly of a treed fen/sedge fen complex. From time to time, naturalists continued to find a few plants here and there in this peatland, usually in the treed fen close to the sedge fen opening. In 1970 and 1971, there were about a dozen plants scattered on the open fen floor; they could not be found there again in 1972 (J. Donald Lafontaine, Sheila and Harry Thomson, personal communications) or in any subsequent year. Logging of the treed fen and swamp between 1983 and 1985 resulted in a vastly changed habitat and it was not until 1989 that a few flowering plants were encountered again, in a small cluster of uncut trees. There were four flowering plants in 1994, 1995 and 1996. In 1996, there were two additional flowering plants nearby in the sedge fen growing among flowering plants of *Arethusa bulbosa*.

The colony in Frontenac County was flourishing in 1959 when Otto Devitt (1961) described the habitat as "rather open". From 1969 until the early 1980s, we recorded many hundreds of flowering plants in and around the frequent clearings. By 1996 the trees had grown considerably but there were numerous *A. rotundifolia* still thriving in the remaining openings. One or two to two dozen (rarely three dozen) flowering plants were present in various openings depending on their size.

The colony in Renfrew County near Westmeath numbered close to 200 plants when Hue and Elva MacKenzie searched the area in 1968 (records of the Native Orchid Location Survey, personal communications). We found a similar number there in 1984, but in 1989 we could find only a few flowering plants.

These patterns of fluctuating numbers are similar to Fred Case's observations in Michigan (Case 1987).

EARLY HISTORY: Dow's Swamp was the first place in the District where *A. rotundifolia* was discovered. The earliest collection was probably the one by R. B. Whyte on 16 June 1878 cited by John Macoun in his undated typescript of about 1911*. The whereabouts of that collection is unknown. Extant herbarium specimens record James Fletcher's collections there in July of 1878, as well as in 1879 and 1882 [DAO 17027 and 17029, MTMG 47597, TRT 15747, US 27620]. *Amerorchis rotundifolia* occurred at Dow's Swamp "in large numbers" along with the similarly abundant orchids, *Cypripedium arietinum* and *Malaxis monophylla* (Whyte and Small 1883). Dow's Swamp was a calcareous treed fen and pond-edge open fen located southeast of Dow's Lake. It

lingered into the middle of the 20th century and was better known in its latter days as a good birding spot (Reddoch 1978b; Illman 1980).

In 1903, John Macoun (*circa* 1911*) encountered *A. rotundifolia* "in the cedar swamp east of Stittsville and a little north of the railway" and made several collections [CAN 117000, DAO 17028, MTMG 8602]. This swamp, which was visited by naturalists a number of times over the years (see, for example, Eddy and Halkett (1913)), was destroyed in 1980 in an expansion of the Amberwood subdivision. In that year, we found *Corallorhiza trifida*, *Cypripedium arietinum*, *Cypripedium reginae*, *Malaxis monophylla* and *Platanthera hyperborea*, as well as *Epipactis helleborine*, but no *A. rotundifolia*, in the rapidly draining swamp.

COLOUR PATTERN VARIANT: *Amerorchis rotundifolia* f. *lineata* (Mousley) Hultén was discovered at the Frontenac County colony in 1959 (Devitt 1961). The form differs from the typical by having two broad purplish stripes on the lip (Mousley 1941).

This description is, however, an oversimplification that does not reflect the highly variable pattern

of lip coloration of the species. In this form, the genetic control of the colour pattern formation appears not to be very rigorous. In the typical form, the small dots, while of fairly uniform size, are quite irregular in their arrangement from one flower to another in the same inflorescence and are also somewhat variable in size from plant to plant. The idealized f. *lineata* is only one aspect of the observed patterns. These include spots that are fewer and larger than typical, as well as mixtures of large spots on one side of the lip and a single stripe on the other, stripes broken into two segments and even a single patch of colour covering the entire centre of the lip. Usually, no two flowers on the same inflorescence have the same patterns. However, the aberrant patterns do not seem to coexist with the typical small spots on the same plant.

The plants with aberrant lip patterns constituted about 15% of the Frontenac County population in 1996. Contrary to the observations of Whiting and Catling (1986), we found that the aberrant-lipped plants grew among plants with typical lips, not in separate groups.

Aplectrum hyemale (Muhlenberg ex Willdenow) Nuttall

Putty-root

Aplectrelle d’hiver

Aplectrum hyemale was reported in the District in the 1880s and in 1905, but no subsequent records are known. Such erratic sightings seem to be characteristic of the species in this part of its range. Unfortunately, the only reported collection can not be found, but the accounts of the discovery of the first colony are convincing enough to accept *A. hyemale* as a historic member of the Ottawa flora.

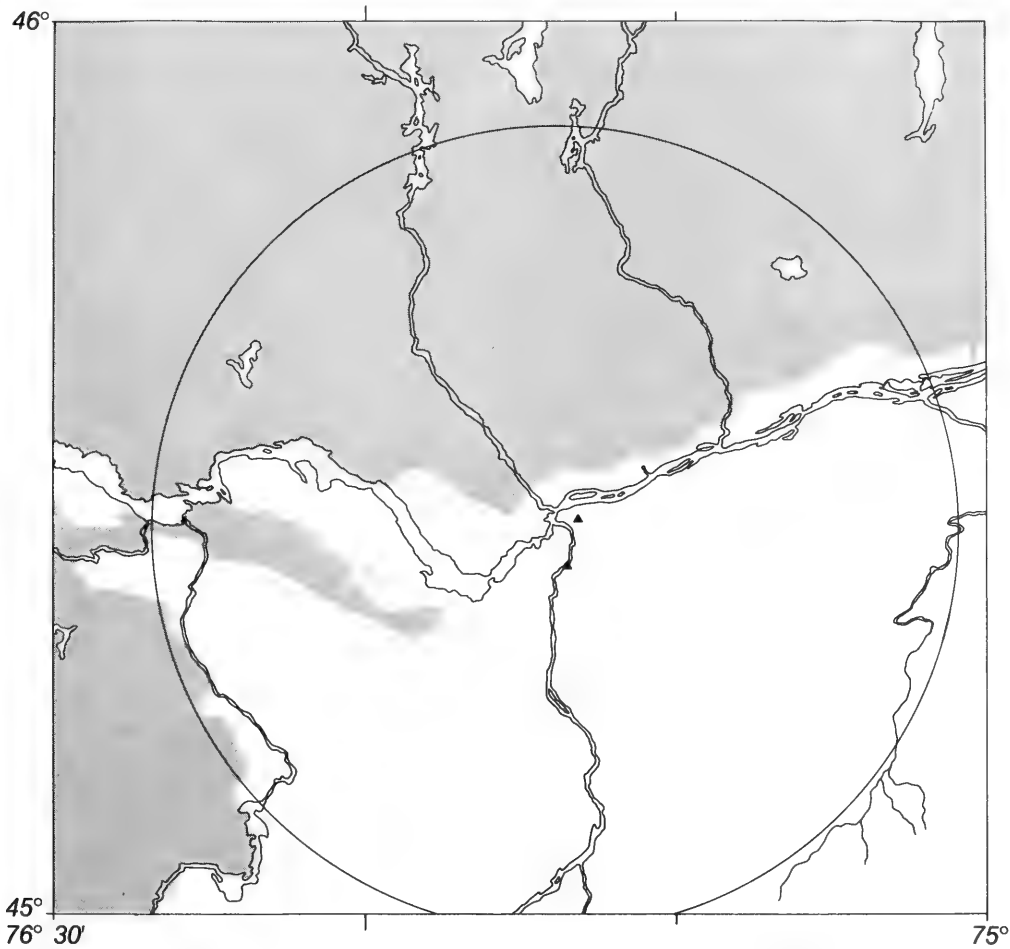
CURRENT STATUS: rare in the Provinces of Quebec (Bouchard et al. 1983) and Ontario (White et al. 1982a), very rare (S2) in Ontario (Active List, Oldham 1996*), rare in Canada (Argus and Pryer 1990); apparently extirpated in the Ottawa District (no plants reported since 1905).

DISTRIBUTION: The Ottawa District is at the northern edge of the distribution of this orchid of the Deciduous Forest Region.

HISTORY: *Aplectrum hyemale* was added to the *Flora Ottawaensis* following its discovery in 1885 by Lieutenant-Colonel William White, the first president of The Ottawa Field-Naturalists’ Club (Whyte, Macoun, and Small 1887). The location was cited as “McKay’s wood” (Fletcher 1887) or “Beechwood” (Fletcher, Small, and Baptie 1887b, 1888; Fletcher

1893). “The woods beyond Rideau Hall [were] popularly known as McKay’s Bush or Beechwood” according to an anonymous account of Club excursions in 1887. This area, stretching eastward from Rideau Hall to present-day St. Laurent Blvd., was a rich and diverse natural area frequented by naturalists for more than 70 years (Reddoch 1979b).

On 15 October 1887, Lieutenant-Colonel White led a group of botanists to the site of his discovery (Fletcher, Small, and Baptie 1887b). “After a short search beneath fallen leaves Mr. Fred Magee succeeded in finding a fine patch of three plants — two of these bore two leaves each.” This event was described again by the same authors (1888) in their Report of the Botanical Branch for the season of 1887. Here they related that the intent of the excursion was to collect “roots of the rare orchid



Aplectrum hyemale: ▲ = literature reference. The Canadian Shield is shaded.

Aplectrum hyemale" and that "a fine patch of seven roots was found by Mr. Fred Magee, three of which were removed for study under cultivation".

There is no indication that a herbarium specimen was prepared. The description of the plants in the 1887 account was minimal, saying, in addition to the quotation above about the leaves, that, in reference to the corms on two of the plants, "there are two of these bulbs on a plant". The account also included a general description of the seasonal development of the species that showed that the authors were well informed on the appearance of the leaves ("a large handsome ribbed leaf ... dark green above and purple beneath") and corms. These descriptions and the presence of the leaves in mid-October make this a credible report. In the 1970s, we and other botanists (Darbyshire 1982) searched in vain for *A. hyemale* in the remnant forests in Beechwood Cemetery and across Hemlock Road on the east side of McKay Lake, now mostly destroyed (Darbyshire 1981).

John Macoun (*circa* 1911*), who was familiar with this orchid from other places in southern Ontario (Macoun 1888), listed his own collection of 13 September 1905 from "cool rich woods Billing's

[sic] bush, Rideau park (15 plants)". This location likely was on the Billings property east of Billings Bridge (Belden 1879). We have not been able to locate this collection in any of the herbaria that we visited or to which we wrote (British Museum (Natural History) (BM), University of Notre Dame (NDG), New York Botanical Garden (NY), University of Calgary (UAC)). Macoun's collections are held in many herbaria throughout North America and Europe.

Three other colonies have been reported some 50 to 80 km beyond the District. At Oka, Quebec, about 100 plants were studied from 1930 to 1942, but no plants have been found there more recently (Lavoie 1994). In 1964, G. N. Gogo collected a plant [DAO s.n.] north of Summerstown, Charlottenburg Township, Glengarry County, Ontario. In May of 1988, Don Cuddy (personal communication) discovered 15 plants in Frontenac Provincial Park, Frontenac County, Ontario, while leading a Field Botanists of Ontario outing. He noted that one of these plants had a flowering stalk. We saw 13 plants there in the autumn of 1989, none of which had flowered that year.

Arethusa bulbosa Linnaeus

Arethusa

Aréthuse bulbeuse

Arethusa bulbosa, regarded by many as one of our most beautiful orchids, is one of the three pink to purple fen orchids in the District. It is the least abundant of the three. It can be distinguished from the other two, *Pogonia ophioglossoides* and *Calopogon tuberosus*, by its essentially erect lateral sepals. It differs from the former by its very small floral bracts and lack of an elliptical cauline leaf, and from the latter by its solitary flower.

DESCRIPTION

Height: 8 (13 - 24) 38 cm [172 plants].

Flowers: 1, rarely 2; usually purple, sometimes purplish red, deep magenta, greyish magenta or light lilac, occasionally purplish pink, purplish white or lighter; lip white with distal border (and sometimes sides) of same colour as sepals or lighter and with stripes of more intense colour, with 3 rows of bristles along centre line pale yellow or lighter; fragrance moderate, sweet, floral, like violets or lilacs.

Leaf: 1, developing to maturity after anthesis, 1 on non-flowering plants.

Overwintering State: as the corm of the current year.

Capsules: greyish brown, ellipsoid to obovoid, typically 2.5 x 0.6 cm, ascending to vertical; yield very low, perhaps a few percent (Boland and Scott

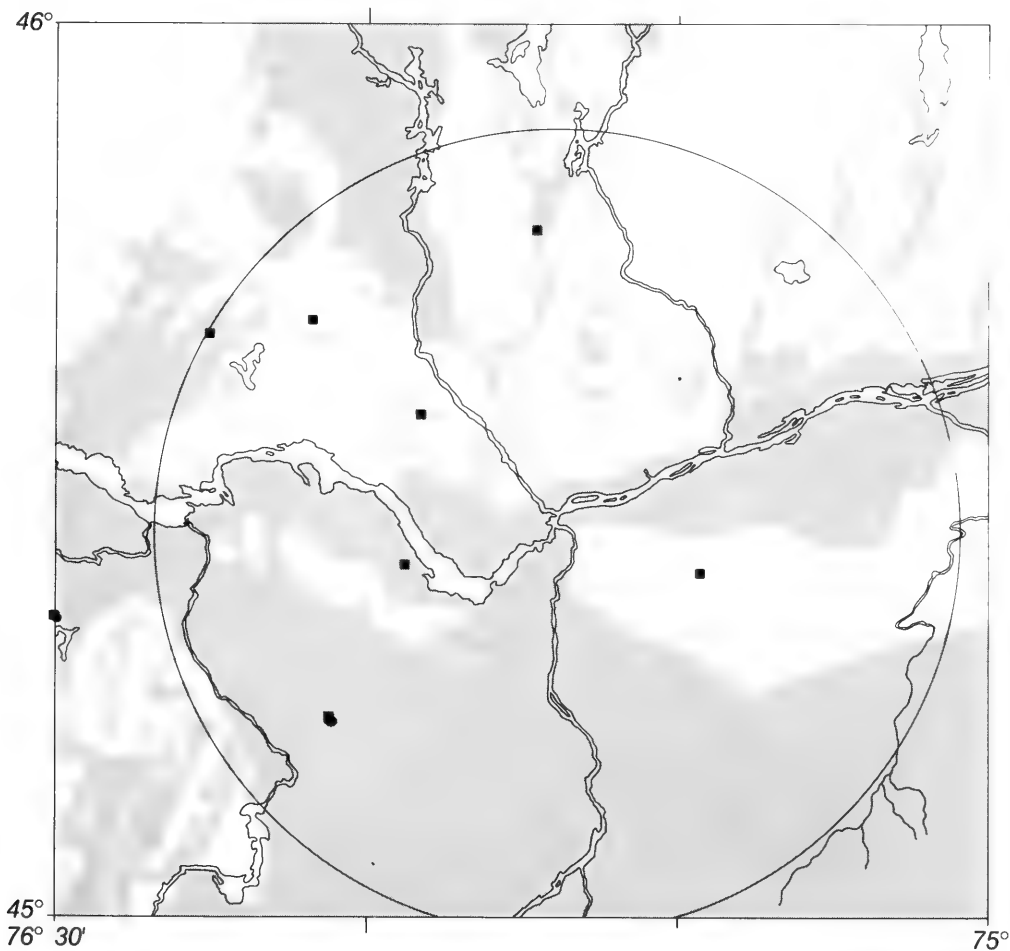
(1991) report 16% in Newfoundland, Thien and Marcks (1972) report 5% in Wisconsin).

Seeds: light brown, released by late September.

BLOOMING PERIOD: 28 May (10 June - 26 June) 3 July [42 records].

COLONY SIZES: 1 - 300 flowering plants [10 records], as scattered individuals; the number of plants counted on a single visit is about a quarter of the plants flowering in a month because individual flowers last only about a week (Ed Greenwood, personal communication 1987, quoted in J. M. Reddoch and A. H. Reddoch (1987d)).

CURRENT STATUS: rare in the Province of Quebec (Bouchard et al. 1983).



Arethusa bulbosa: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record. Major areas underlain by calcareous rock (marble and limestone) are shaded.

DISTRIBUTION: The Ottawa District is close to the northern edge of the range of this Great Lakes — St. Lawrence — Atlantic Coast orchid. It is a species of the Mixed Forest Region and adjacent parts of the Deciduous and Boreal Forest Regions. Within the District, *A. bulbosa* occurs in a few peatlands on the Canadian Shield and on the Lowlands, mostly in areas of calcareous bedrock.

HABITATS: *Arethusa bulbosa* is confined to calcareous treed and open fens (intermediate to rich fens) and the minerotrophic parts of bogs (poor fens). Most colonies occupy the semi-open treed fen zone surrounding open sedge fens. Here the plants are supported in deep, moist leaf humus or mounds of *Sphagnum* and other mosses on hummocks around the bases of Eastern White Cedar, Tamarack and Black Spruce. Common substrate mosses are *Sphagnum warnstorffii*, *S. teres*, *S. magellanicum* and *S. russowii*. Some companion vascular plants are Three-leaved False Solomon's Seal (*Smilacina trifolia*), Sweet Gale (*Myrica gale*), Pitcher-plant (*Sarracenia purpurea*), Buckbean (*Menyanthes trifoliata*), Bog Rosemary (*Andromeda glaucophylla*), Labrador Tea (*Ledum groenlandicum*) and Small Cranberry (*Vaccinium oxycoccos*). The corm of one flowering plant of *A. bulbosa* that we discovered at White Lake Fen was lodged in the bark of an Eastern White Cedar tree about 5 cm above the hummock surface.

Occasionally, *A. bulbosa* is found in the open among the sedges of the fen floor if it is not too wet, and sometimes the odd plant turns up in an opening in a cedar swamp adjacent to the treed fen zone containing the main colony.

Arethusa bulbosa usually occurs in the same fens as do *Calopogon tuberosus* and *Pogonia ophioglossoides*, but while the latter two orchids flourish on the wet, open fen floor, *A. bulbosa* usually is found in somewhat higher areas.

LONG-LIVED COLONY: We have followed the progress of the colony in the calcareous fen near Poltimore (Reddoch 1989) since 1967. During the 1970s, the fen became increasingly wetter and the plants scattered over the fen floor disappeared. At the same time, dozens of new plants began to flower on the hummocks surrounding the trees along the edges of the fen and have continued to thrive there. In the 1990s, flowering plants again appeared on the fen floor close to those on the hummocks.

EARLY HISTORY: *Arethusa bulbosa* was added to the *Flora Ottawaensis* in 1883 when it was discovered in the Mer Bleue Bog growing among hundreds of *Pogonia ophioglossoides* ([MTMG 47593], Fletcher 1884, Macoun, Whyte, and Fletcher 1884). Subsequent visitors, apparently to the same locality "near the gas springs" at the south edge of the peatland near Carlsbad Springs, reported large numbers of plants (Whyte, Craig, and Cowley 1894; Fletcher 1896; Whyte, Craig, and Macoun 1897; Gibson 1908). Between 1883 and 1912, at least sixteen collections were made in the Mer Bleue and distributed to various Ontario and Quebec herbaria. There has been only one recent report of *A. bulbosa* in the Mer Bleue, that of Shirley Black (personal communication 1980) of the National Capital Commission, who noticed a few plants east of the Borthwick Ridge in the early 1970s.

ACYANIC FORM: *Arethusa bulbosa* f. *albiflora* Rand and Redfield has been reported from the fen near Poltimore by Brunton (1985). While we have seen several very pale flowers, there and elsewhere, as described above, they still have some anthocyanin and do not represent f. *albiflora*. This form has also been reported from Alfred Bog, east of the Study Area, by Emerson Whiting (personal communication circa 1980).



FIGURE 3. *Arethusa bulbosa*, sedge fen habitat, Val-des-Monts Municipality (Wakefield Township, Gatineau County), Quebec, 20 June 1976.

Calopogon tuberosus (Linnaeus) BSP.

Grass-pink

Calopogon tubéreux

SYNONYM: *Calopogon pulchellus* (Salisbury) R. Brown

Calopogon tuberosus is the most conspicuous of the three purple to pink peatland orchids of the District with its several brightly coloured flowers. It can be distinguished from the others, *Arethusa bulbosa* and *Pogonia ophioglossoides*, by its several flowers with lips uppermost. It differs from the former by its spreading lateral sepals and from the latter by the absence of a cauline leaf.

DESCRIPTION

Height: 18 (30 - 46) 64 cm [180 plants], at most half the height of some plants in the southern part of the range (Luer 1975).

Flowers: 1 (2 - 5) 10 [150 plants], at most half the number of some plants in the southern part of the range (Luer 1975); purple, occasionally light lilac or greyish magenta; lip erect but lying on column after fertilization, with 3 rows of white clavate hairs, sometimes orange yellow or light yellow at the tips; fragrance very faint floral or lacking.

Leaf: 1, 1 on non-flowering plants.

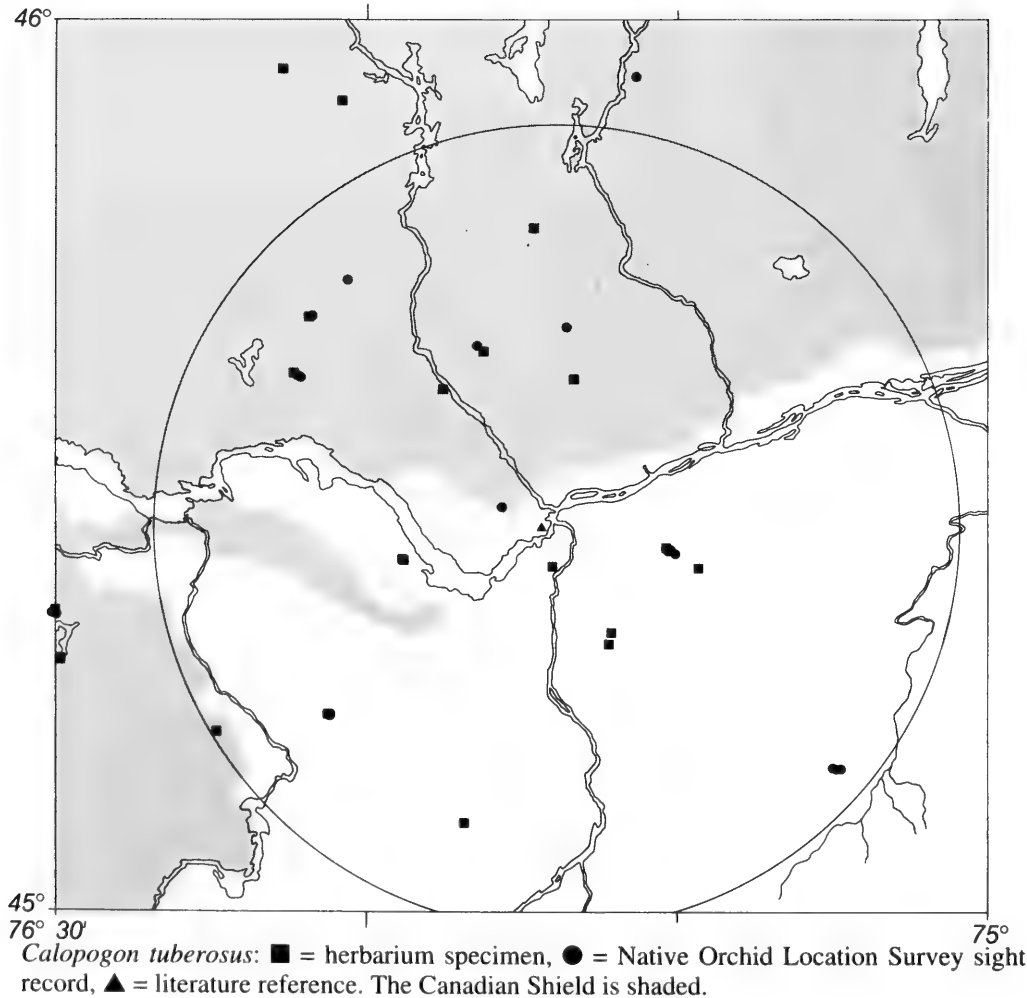
Overwintering State: as the corm of the current year.

Capsules: light brown, ellipsoid, typically 1.5 x 0.6 cm, erect or nearly so; yield highly variable, averaging 55% [62 plants], appreciably larger than reported for Newfoundland, 19% (Boland and Scott 1991), for Maine, 24% (Firmage and Cole 1988) and Wisconsin, 16% (Thien and Marcks 1972).

Seeds: pale yellow to pale orange, released in early September.

BLOOMING PERIOD: 12 June (24 June - 18 July) 6 August [85 records].

COLONY SIZES: 1 - 400, typically to 165, flowering plants, one exceptional colony with an estimated 3000 flowering plants on a lake-edge fen in the



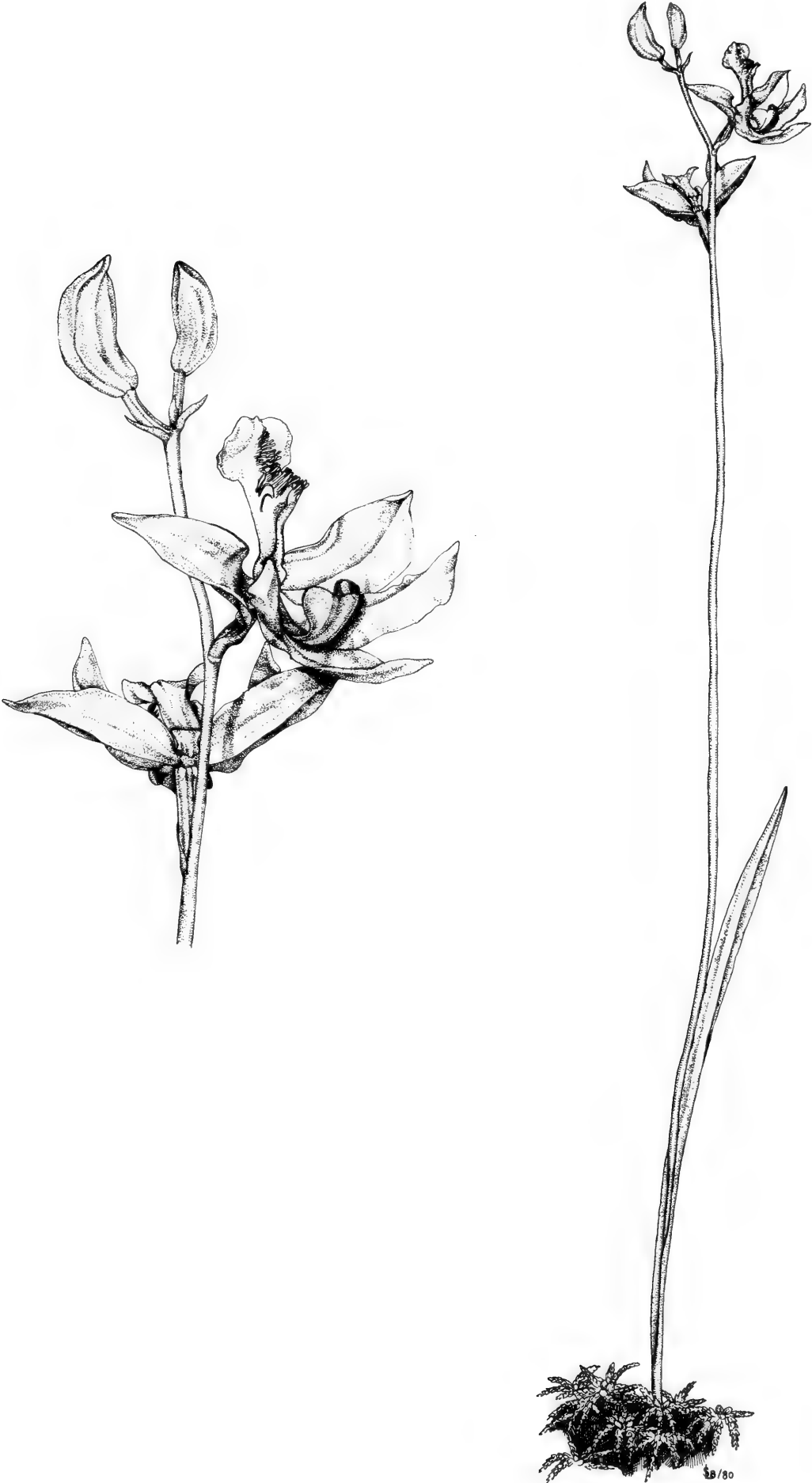


FIGURE 4. *Calopogon tuberosus*, bog habitat, Val-des-Monts Municipality (Wakefield Township, Gatineau County), Quebec, 2 August 1980.

southwest (Adolf Vogg, personal communication 1988) [32 colonies], as scattered individuals.

DISTRIBUTION: The Ottawa District is in the northern part of the distribution of this eastern orchid. It is a species of the Deciduous, Mixed and Southeastern Coastal Plain Forest Regions and adjacent edges of the Boreal Forest. It is also found in subtropical Florida and in Cuba. Within the District, *C. tuberosus* is confined to several peatlands and related areas scattered across the Canadian Shield and the Lowlands.

HABITATS: *Calopogon tuberosus* is most commonly encountered in the minerotrophic parts of bogs (poor fens) and intermediate to rich fens, both floating and consolidated, and sometimes in openings in treed fens. The plants rise from corms deep in the wet peat among typical peatland vegetation. *Calopogon tuberosus* is almost always accompanied by *Pogonia ophioglossoides* in these peatlands.

Occasionally, colonies appear from time to time adjacent to large bogs on open, moist sands that have been cleared temporarily of competing vegetation by excavation (Mer Bleue Bog) or by fire (Morewood Bog). These colonies are particularly susceptible to lowering of water levels, disappearing entirely after a drought.

Overburden stripping in the 1960s on the Dolman Ridge beside the Mer Bleue Bog left open stretches of mesic to wet-mesic sand beside the lagg of the bog. The sand (pH 4.5 - 5.0) was quickly colonized by old-field and bog plants, including Field Horsetail (*Equisetum arvense*), Wood Horsetail (*E. sylvaticum*), Poverty Grass (*Danthonia spicata*), Hudsonian Club-rush (*Scirpus hudsonianus*), Wild Iris (*Iris versicolor*), Blue-eyed Grass (*Sisyrinchium angustifolium*), Buttercup (*Ranunculus acris*), Wild Strawberry (*Fragaria virginiana*), Silvery Cinquefoil (*Potentilla argentea*), Rough-fruited Cinquefoil (*P. recta*), Dewberry (*Rubus hispidus*), Meadowsweet (*Spiraea latifolia*), Steeplebush (*S. tomentosa*), Cow Vetch (*Vicia cracca*), Evening-primrose (*Oenothera biennis*), Sheep Laurel (*Kalmia angustifolia*), Labrador Tea (*Ledum groenlandicum*), Blue Vervain (*Verbena hastata*), fleabane (*Erigeron* sp.), and Brown-eyed Susan (*Rudbeckia hirta*). In the early 1970s, five orchids also grew in one such field: *Calopogon tuberosus*, *Liparis loeselii* and *Platanthera lacera* in both the mesic centre of the field and the wet-mesic border beside the lagg, *Malaxis unifolia* in the mesic centre of the field, and *Spiranthes cernua* beside the lagg. *Pogonia ophioglossoides* appeared one year in the centre of the field. The colony of *C. tuberosus* was likely seeded from the 600 or so flowering plants across the lagg in the bog. It built up to about 50 flowering plants in 1973, but there was none at all in the dry summer of 1975 and in subsequent years. The field filled in rapidly with *Spiraea* and Speckled Alder

(*Alnus rugosa*), and the orchids soon disappeared. In 1978, there was one flowering plant of *C. tuberosus*, along with a few flowering plants of *Malaxis unifolia*. In 1980, two *Liparis loeselii* were the only orchids found.

Beside the Morewood Bog in the late 1970s, the area of an old burn supported about 25 flowering plants of *Calopogon tuberosus*, two *Liparis loeselii*, six *Spiranthes lacera* and about 50 *Malaxis unifolia*. The sand substrate was covered with patches of lichens, *Polytrichum* and *Sphagnum* mosses, and Staghorn Clubmoss (*Lycopodium clavatum*). Other plants noted were White Beak-rush (*Rhynchospora alba*), Round-leaved Sundew (*Drosera rotundifolia*), Dewberry, Pink Pyrola (*Pyrola asarifolia*), Leatherleaf (*Chamaedaphne calyculata*), Sheep Laurel and Labrador Tea. Grey Birch was the dominant tree nearby.

EARLY HISTORY: On 9 July 1860, Braddish Billings Jr. collected both *C. tuberosus* [QK 12563] and *Pogonia ophioglossoides* at Dow's Swamp, presumably on the sedge fen mat surrounding the small pond shown in the 1925 air photo (Reddoch 1978b). He described both orchids as rare. He also included *C. tuberosus* among the plants he collected in the vicinity of Ottawa during the summer of 1866 (Billings 1867). James Fletcher collected *C. tuberosus* at Dow's Swamp in 1878 [DAO 17646] and stated in his *Flora Ottawaensis* of 1893 that it was rare there. The species was collected there again in 1902 [CAN 227228].

Other early collections were those of John Kerr McMorine in 1862 from Ramsay, Ontario [QK 66597, DAO 17651 (photograph of the latter in Ross 1984)].

Henry Ami's 1879 specimens from the Mer Bleue Bog near Carlsbad Springs [CAN 232431, MTMG 3442] were the first of many from that peatland. James Fletcher (1893) stated that *C. tuberosus* occurred "in enormous profusion in the Mer Bleue and at Lake Flora, Hull". Lake Flora was a small pond on l'Île de Hull (Nagy 1974) that is now Parc Fontaine. This species, along with *Pogonia ophioglossoides* and *Spiranthes romanoffiana* (listed as *S. cernua*) (Fletcher 1893), probably grew on a sedge fen mat on the edge of the pond.

ACYANIC FORM: *Calopogon tuberosus* f. *albiflorus* Britton has not been reported from the Study Area but should be watched for since it has been seen in a fen in Leeds County not far south of the District by E. W. Greenwood (1965 letter to W. K. W. Baldwin, at CAN).

ABERRATION: One unusual plant of *C. tuberosus* that we collected [DAO 691503] on a sedge mat (poor fen) near St.-François-de-Masham, Quebec, had three flowering scapes and two small leaves arising from a single corm. The scapes bore 4, 6 and 10 flowers.

Calypso bulbosa (Linnaeus) Oakes var. *americana* (R. Brown) Luer

Calypso, Fairy Slipper Calypso bulbeux

SYNONYM: *Calypso borealis* (Swartz) Salisbury

Calypso bulbosa is a rare plant of cedar swamps that is among the first orchids to bloom in the spring. It can be recognized by its single, pleated, basal (often seemingly detached) leaf and its single pink to purple flower with a saccate lip with white apron and twin points at the apex. Because of the scarcity of living plants in the area, heights, colours, blooming period and colony sizes below are based, in part, on observations made at two now extinct colonies in Eastern Ontario.

DESCRIPTION

Height: 6 (7 - 13) 15 cm [31 plants].

Flower: 1; sepals and petals purplish red, purplish pink or reddish lilac; column similar but lighter in colour, sometimes white; lip white, sometimes purplish white at end of apron, light yellow on 3 rows of hairs and on apron beneath them, slightly greyer yellow on twin tips at apex, with ruby spots on apron and on hairs, sometimes symmetrically placed, and somewhat darker ruby lines within pouch; fragrance rose-like or lacking.

Scape: greyish magenta or reddish lilac.

Floral bract and sheaths: purplish grey.

Leaf: 1, 1 on non-flowering plants; formed in late summer, overwintering and dying after anthesis.

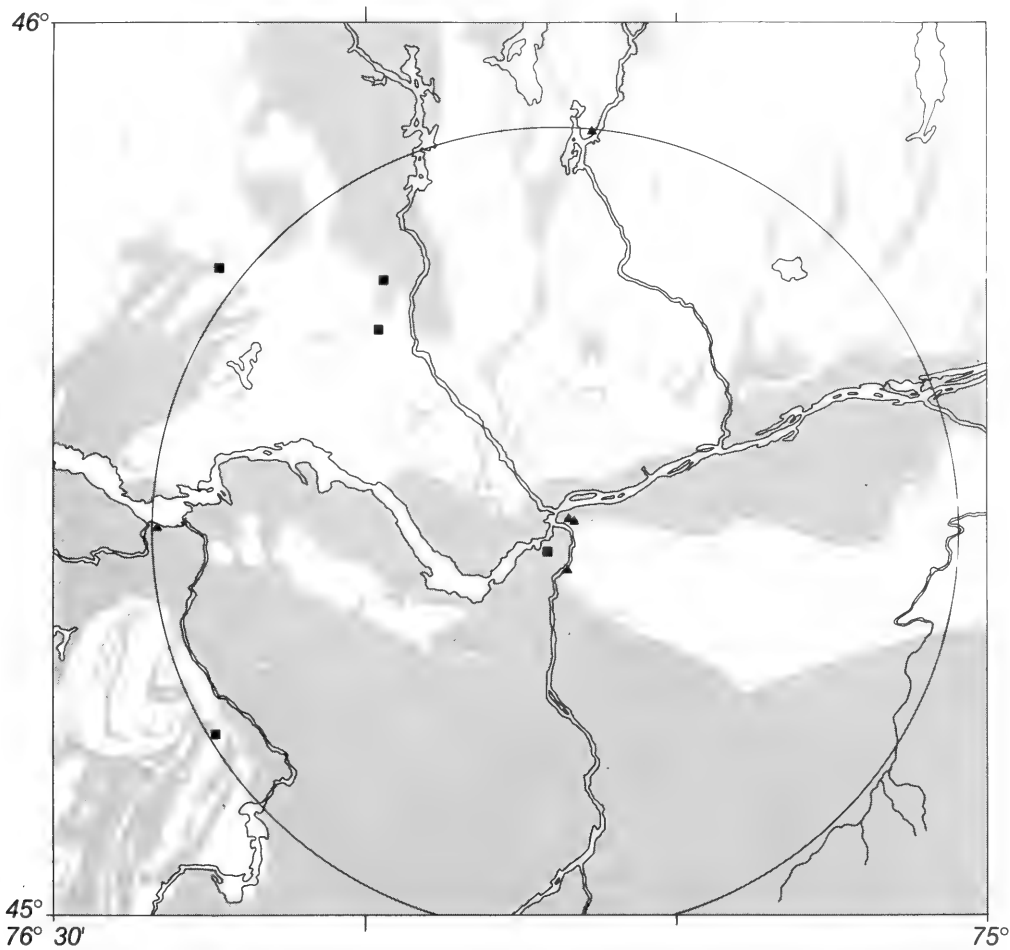
Overwintering State: as the corm of the year subtending a leaf (see above).

Capsule: light brown, ellipsoid, typically 1.5 x 0.6 cm, erect; pedicel, about 0.6 cm long at anthesis, continuing to grow to 4 - 6 cm long when capsule mature (from herbarium specimens elsewhere in Ontario and Quebec);

Seeds: colourless with orange white embryos (from herbarium specimens elsewhere in Ontario and Quebec).

BLOOMING PERIOD: 13 May (20 May - 7 June) 11 June [13 records].

COLONY SIZES: up to 25 flowering plants [5 colonies], generally as scattered individuals; occa-



Calypso bulbosa var. *americana*: ■ = herbarium specimen. Major areas underlain by calcareous rock (marble and limestone) are shaded.

sionally as clumps of up to 5 plants, all flowering or a mixture of flowering and non-flowering plants.

CURRENT STATUS: rare if not extirpated in the Ottawa District; one recently-discovered colony just beyond the 50-km circle in Quebec; species declining throughout the southern part of its range in Ontario (Whiting and Catling 1986).

DISTRIBUTION: The Ottawa District is near the southern edge of the transcontinental distribution of this orchid in North America. This variety is a plant of the Boreal Forest Region and adjacent Mixed Forest, as well as of the Montane Forest.

Within the District, the few localities known to have harboured this orchid were on both the Canadian Shield and the Lowlands. Outside the District, the nearest known colonies in Ontario were on the Shield 100 km west of Ottawa in Frontenac and in Renfrew Counties. The former was discovered by Elva MacKenzie in 1970 and the latter by Sheila Thomson in 1979. Both colonies now appear to be extinct. In Quebec, 70 km north of Ottawa, Theresa Aniśkiewicz found and photographed a single plant at Heney Lake in 1971. *Calypso bulbosa* is confined to areas of calcareous bedrock.

HABITATS: *Calypso bulbosa* inhabits calcareous, semi-mature to mature Eastern White Cedar swamps. The plants grow in partially open places in moist needle-mould on mounds around trees or on the moist to wet swamp floor.

The colony just outside the 50-km circle near Wolf Lake (see History below) is apparently of recent origin. The plants appeared in an opening created by a survey line cut through an ancient Eastern White Cedar - Balsam Fir - Black Ash swamp where one of the cedar stumps revealed 230 annual rings (Ray Chipeniuk and Sonia Sawchuk, personal communication 1993). The plants grew on mounds and in hollows with such other species as Oak Fern (*Gymnocarpium dryopteris*), Wild Lily-of-the-valley (*Maianthemum canadense*), *Platanthera obtusata*, Foamflower (*Tiarella cordifolia*), dewberry (*Rubus* sp.), Kidney-leaved Violet (*Viola renifolia*), bedstraw (*Galium* sp.), Twinflower (*Linnaea borealis*) and Red Maple shoots.

The Renfrew County site was a similarly ancient cedar swamp. A tight clump of four flowering plants grew on the moist swamp floor beside a large fallen tree in 1979. Sheila and Harry Thomson did not see them again, although they discovered two other flowering plants nearby in two different years since (Sheila Thomson, personal communication 1996).

The Frontenac County Eastern White Cedar - White Spruce - Tamarack swamp was somewhat younger. The trees were fairly closely spaced but were free of live branches for three to five metres from the ground. The *C. bulbosa* plants grew on mounds around the cedars in small openings, not in the densest part of the stand. In 1973, there were 25 flowering

plants and many non-flowering plants, in 1975 and 1979, four flowering plants and a dozen or more non-flowering plants. No plants could be found in the mid-1980s (David White, personal communication).

At Heney Lake, the single flowering plant was in a somewhat different habitat, a semi-mature coniferous forest on a slope above the lake (Theresa Aniśkiewicz, personal communication 1981).

HISTORY: This orchid was rather less rare in earlier times than it is now. It was first found at several localities close to the new city, too close to survive for long. In 1856, Elizabeth Keen White painted a plant gathered from "Wet woods. Ottawa" by her husband, William White (Dore 1965*). Stewart's Bush, the "damp, rich wood" where James Fletcher made the first herbarium collections in 1877 [DAO 17808, MTMG 47281], was already being cleared six years later (Macoun, Whyte, and Fletcher 1884). In modern terms, the bush was west of the Victoria Memorial Museum between Bank Street and Bronson Avenue.

Fletcher (1893) also reported it from Billings Bridge, where he found it abundant in 1878 but could not find it at all after that. John Macoun (*circa* 1911*) noted it at several other localities close to the city: "a few specimens occasionally found around the swamp in front of Beechwood cemetery old entrance gate" and "one specimen found near Rideau Hall grounds in the spring of 1895 by young Mr. Frechette", as well as reporting R. B. Whyte's collections at "McKay's Woods near Beechwood", 1879, and "Beechwood", 1888.

At the western edge of the District in Ontario, Robert Campbell collected *C. bulbosa* at "Ramsay near Almonte" in 1897 [DAO 204317, MTMG 20282, 20283], and Charles Macnamara found five plants (and photographed one) in "thick mossy woods" near Arnprior in 1915 (Macnamara *circa* 1940*; Reddoch 1981c).

To the north, in Quebec, R. B. Whyte collected *C. bulbosa* at High Falls on the Lièvre River north of Buckingham in 1892 (Fletcher, Scott, and Cowley 1892; Macoun *circa* 1911*). In 1898, John Macoun discovered it at Chilcott's Swamp, west of Alcove [TRT 15300], and Faith Fyles found one flowering plant there in 1911 ([DAO 200666], Fyles 1912). In the 1950s, two specimens (at DAO) were collected from Lac Gauvreau west of Wakefield.

Members of the Native Orchid Location Survey did not turn up any colonies of *C. bulbosa* during their years of intensive study of the Ottawa District beginning in 1965. In 1993, Ray Chipeniuk and Sonia Sawchuk discovered eight flowering plants on their property northwest of Wolf Lake and just outside the District [photographs DAO 668349]. The next year, we found nine flowering plants and nine non-flowering plants there. In 1995, Ray and Sonia (personal communication 1996) counted five flowering plants, and, in 1996, one flowering plant.

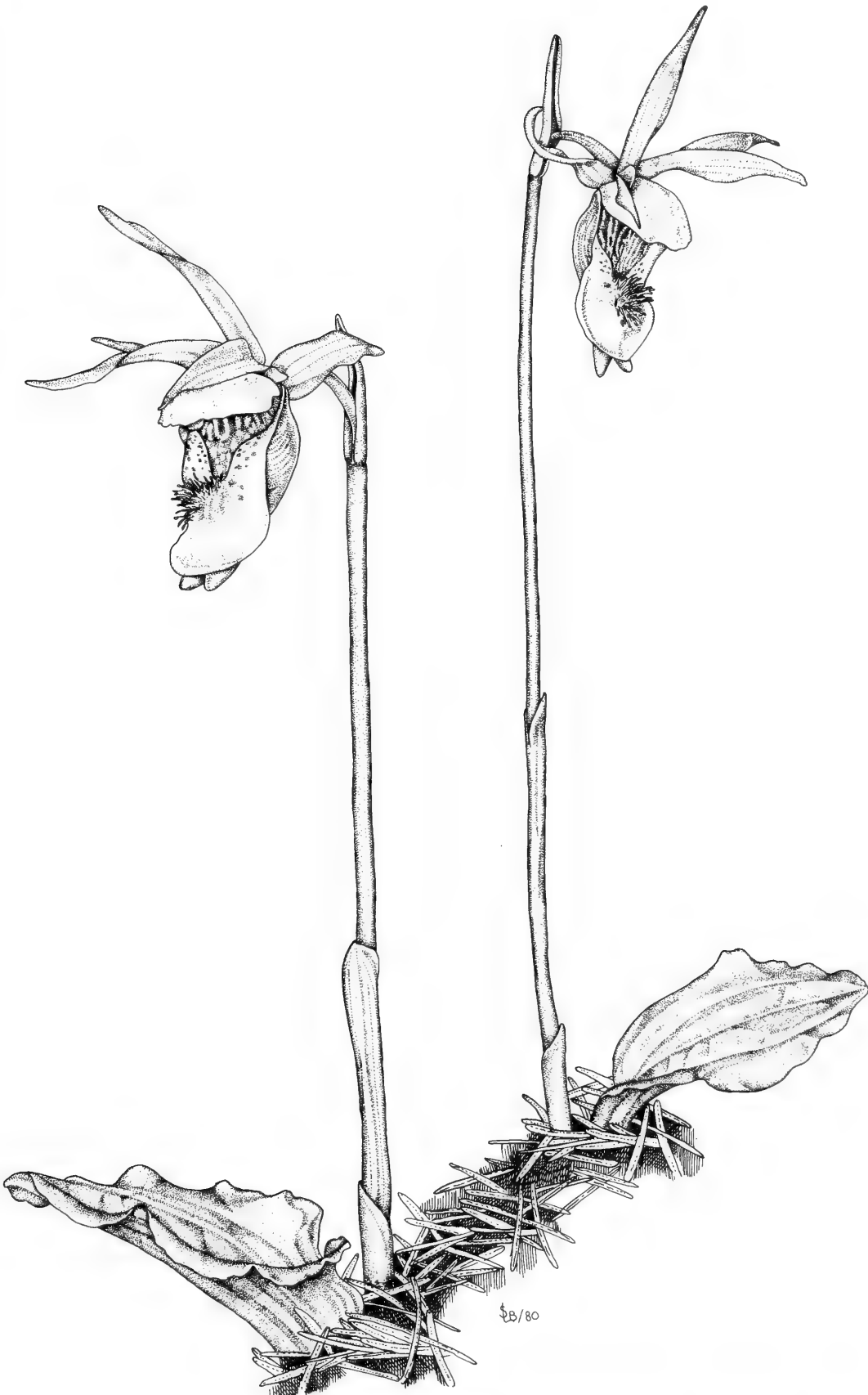


FIGURE 5. *Calypso bulbosa* var. *americana*, cedar swamp habitat, Clarendon Township, Frontenac County, Ontario, 30 May 1973 and 2 June 1975.

Coeloglossum viride (Linnaeus) Hartman var. *virescens* (Muhlenberg) Luer

Long-bracted Orchid

Orchis à longues bractées

SYNONYMS: *Habenaria viridis* (Linnaeus) R. Brown, *Habenaria bracteata* (Muhlenberg) R. Brown

Coeloglossum viride is a spring-blooming, green, forest orchid that occurs infrequently and does not seem to survive for many seasons. It can be recognized by its cauline leaves, by the floral bracts which are as long as the flowers at the top of the inflorescence and much longer at the bottom, and by the lip which is strap-like in shape with a notch at the end and which is much longer than the shallow bulbous spur.

DESCRIPTION

Height: 14 (19 - 29) 40 cm [53 plants], appreciably shorter than the 50 or 60 cm or more cited by various authors (for example, Luer 1975).

Flowers: 4 (5 - 16) 28 [41 plants]; greyish green, occasionally somewhat more yellow; lip usually, but not always, with coloration such as brownish red of varying intensity and extent near base; fragrance faintly spicy or apple blossom.

Leaves: 2 - 5, usually 4, less frequently 3; 2 on non-flowering plants.

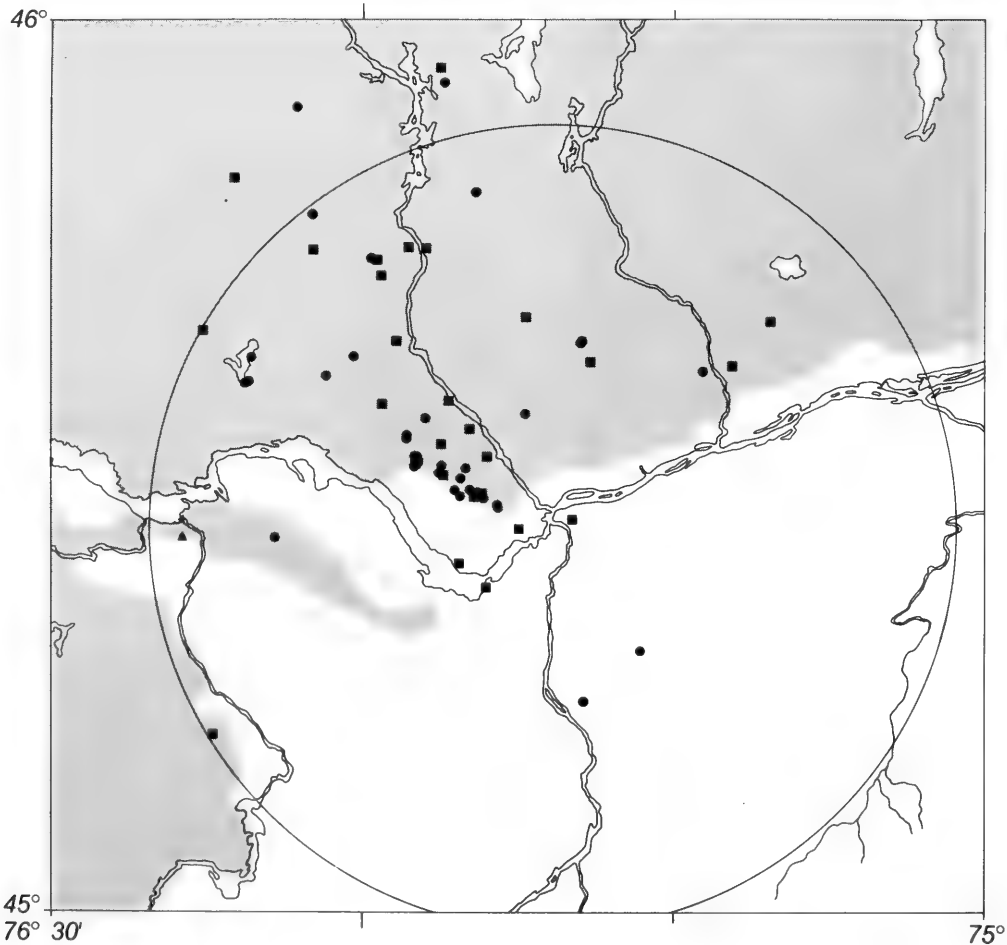
Overwintering State: a greyish green, broadly conical shoot, 1 - 2 cm above ground beside the current year's stem, appearing there in late September;

Currah, Smreciu, and Hambleton (1990) describe the underground seasonal development of *C. viride* in Alberta: during dormancy, the new shoot is subtended by a new, fully elongated, tuberous rhizome and four fleshy roots; a new plant begins development a year before flowering.

Capsules: brown, ellipsoid, typically 0.8 x 0.35 cm, ascending to erect; yield generally fairly high, sometimes approaching 100%, averaging 75% for 10 plants.

Seeds: light brown, released in mid September.

BLOOMING PERIOD: 10 May (25 May - 26 June) 9 July [45 records]; however, by mid-June the column may be no longer functional although the sepals and



Coeloglossum viride var. *virescens*: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record, ▲ = literature reference. The Canadian Shield is shaded.



FIGURE 6. *Coeloglossum viride* var. *virescens*, deciduous forest habitat, Gatineau Park, Quebec, 4 June 1978.

petals remain in good form and may continue to be so for another month. The persistence of flower parts in good form may be the source of some records of late-blooming plants.

COLONY SIZES: 1 - 27 flowering plants; 3 or fewer in 70% of colonies [44 colonies], usually as separate individuals, rarely as pairs (in one case, two stems arising from one of the previous year).

DISTRIBUTION: The Ottawa District is close to the northern regional limit of the transcontinental distribution of this plant of the southern Boreal, Mixed and northern Deciduous Forest Regions. Within the District, *C. viride* is confined almost completely to the Canadian Shield north of the Ottawa River. The lower part of Gatineau Park is a favoured area.

HABITAT: *Coeloglossum viride* inhabits semi-mature to mature, deciduous and mixed forests of such trees as Sugar Maple, Hop Hornbeam, Butternut (*Juglans cinerea*), White Birch and White Pine. Plants generally grow in the partial shade of forest clearings and edges or among widely-spaced trees. The leaf-covered soil is generally well-drained and often rocky. Ground cover in forests is usually sparse or non-existent, but in clearings and along trails may be a mixture of forest and old-field species such as Bladder Campion (*Silene vulgaris*), Hairy Sweet Cicely (*Osmorhiza claytonii*), Fragrant Bedstraw

(*Galium triflorum*), Yarrow (*Achillea millefolium*), asters (*Aster* spp.) and some grasses.

LONGEVITY: It is easy to get the impression that *C. viride* is quite transient. A plant will appear where there was none before and then will not be there on the next visit a few years later. The longest record that we have for individual plants is four years after we discovered them. Charles Macnamara (1911, *circa* 1940*) found the same plant for seven years "under a moose-wood bush" in the Arnprior area. He photographed the plant in 1906.

EARLY HISTORY: In June 1862, J. K. McMorine collected *C. viride* at Ramsay, Ontario [QK 12943]. Also on the western edge of the District, R. B. Whyte collected this species on 25 July 1876 "near Arnprior" (Macoun *circa* 1911*), probably near his family home at Galetta. Like many of R. B. Whyte's collections, this one may no longer be extant. Other early collections came from places closer to the city, beginning with James Fletcher's from "below Beechwood Cemetery" in 1878 [DAO 17299]. Macoun (*circa* 1911*) cites a collection by William Scott from King Mountain in 1892, which was soon followed by others from the Gatineau Valley and other parts of the Canadian Shield north of the Ottawa River.

James Fletcher (1893) considered this species to be "not common", while Macoun (*circa* 1911*) reported it to be "local and scarce".

Corallorhiza maculata (Rafinesque) Rafinesque var. *maculata*
Corallorhiza maculata (Rafinesque) Rafinesque var. *occidentalis*
(Lindley) Ames

Spotted Coral-root

Corallorhize maculée

SYNONYM: *Corallorhiza multiflora* Nuttall

Corallorhiza maculata is a widely distributed orchid of the forests of the Shield which displays considerable variation in colour. It can be identified by its leafless habit, its overall colour in the range from magenta to brown to yellow and its several flowers with white lips with, or rarely without, reddish spots.

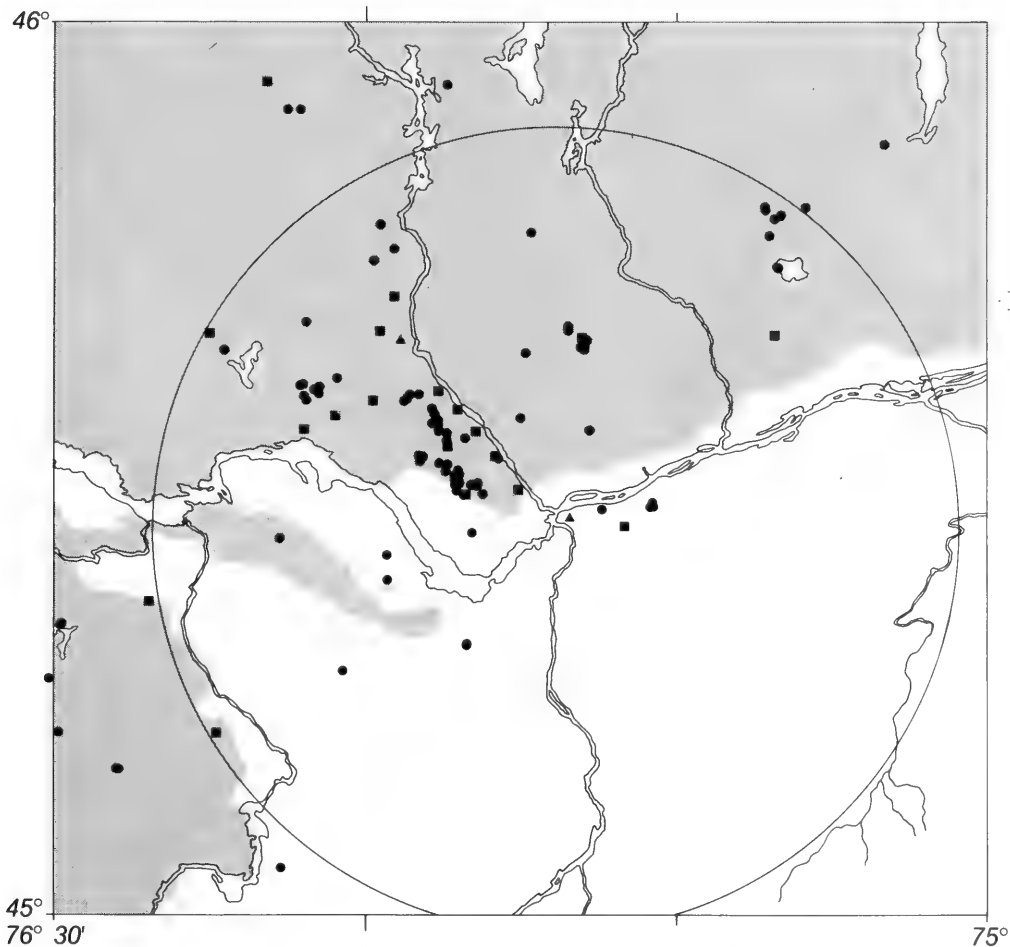
DESCRIPTION

Height: 10 (18 - 33) 49 cm [169 plants].

Plant colours: stem ranging from violet brown, brownish violet, greyish rose or greyish red to yellowish brown or light brown to greyish yellow depending on the relative amounts of red and yellow pigments, sometimes with decreasing red toward top of stem; sheath generally paler than stem, e.g., greyish red to yellowish white with or without fine reddish lines on veins; in f. *flavida* (see Acyanic Form below): entire plant (except lip) yellow, or less frequently, light yellow, greyish yellow or greenish yellow.

Flowers: 4 (8 - 19) 31 [111 plants]; on typical form: sepals greyish yellow, light yellow, yellowish white, greenish white or occasionally brownish orange; tips of sepals ruby or violet brown; lip white; lip, column, petals and sepals with deep magenta, ruby or dark purple spots; in f. *flavida*: lip white without spots; fragrance of typical form sweet, like apple blossoms.

Overwintering State: one or more pale green shoots, several centimetres below ground, rising from coralloid rhizomes near the current year's stem(s), by early fall.



Corallorhiza maculata (both varieties): ■ = herbarium specimen, ● = Native Orchid Location Survey sight record, ▲ = literature reference. The Canadian Shield is shaded.

Capsules: light brown, ellipsoid, typically 1.5 x 0.5 cm, pendent; yield usually 50% to 100%, averaging 70% [58 plants] (often very low or none in drought years or when attacked by weevils).

Seeds: pale yellow, released in mid September.

BLOOMING PERIOD: 3 June (30 June - 28 July) 2 August [56 records].

COLONY SIZES: 1 - 37, typically to 15, flowering stems [93 colonies]; as scattered individuals and in clumps of up to a dozen or so stems.

DISTRIBUTION: The Ottawa District is near the northern edge of occurrence of this transcontinental orchid. It is a species of the Montane, southern Boreal, Mixed and northern Deciduous Forest Regions in Canada and the United States. It is also found in Mexico and adjacent Guatemala. Within the District, *C. maculata* is confined mainly to the Canadian Shield, where it is widespread.

HABITATS: *Corallorhiza maculata* is exclusively a woodland species. It inhabits mesic, semi-mature and mature, deciduous and coniferous forests. The deciduous tree communities are most commonly Beech, Sugar Maple - Beech and Sugar Maple - Red Oak. Eastern Hemlock is by far the most common type of coniferous forest. Even in deciduous forests, the orchids tend to be near hemlock trees if they are present (as Michael Runtz (1984) has noted in the Arnprior area). The most common companion species on the shaded, leaf-covered forest floors is Wild Lily-of-the-valley (*Maianthemum canadense*), accompanied by tree seedlings in somewhat less shaded locations. Sands and sandy loams are the usual substrates.

There are enough observations of colonies on forested slopes at the edges of ponds, swamps and peatlands, and sometimes in the humus-rich soil of the wetland perimeters, to consider these as special microhabitats within the broader forest descriptions.

LONG-LIVED COLONY: Since 1975, we have followed a colony of *C. maculata* in lower Gatineau Park that Anne Hanes discovered and photographed in 1965. The colony consists of both the typical form and f. *flavida*. John Freudenstein annotated our photographs of both forms from this colony [DAO 468578, 478803] as var. *maculata*. The plants are scattered over both level and sloped areas under a canopy of Beech with a sprinkling of Eastern Hemlock, Sugar Maple and Hop Hornbeam. Since 1975, we have seen a total of 85 flowering stems. The number of flowering stems appearing in a year has varied rather randomly from 0 to 11 between 1975 and 1985 and from 1 to 6 between 1985 and 1996. Many of these stems occurred as isolated individuals, but clusters of 3 or 5 stems were noted. Often the individual stems did not reappear the fol-

lowing year, but some members of a five-plant cluster did. (See also Acyanic Form below.)

EARLY HISTORY: In September 1861, John Kerr McMorine collected *C. maculata* at Ramsay, Ontario [QK 12620]. We have encountered three other nineteenth century specimens: a previous year's stalk collected by James Fletcher on 15 May 1879, from "Swamp, Ottawa, Ont." [DAO 17734]; two stems rising from a single rhizome collected by W. Macoun in July 1886 from "Ottawa, Ont." [MTMG 2376]; and a Quebec specimen collected by W. Scott on 25 June 1891 from North Wakefield (= Alcove) [CAN 17165, 100563]. Fletcher (1893) describes this orchid as rare and lists Beechwood, Clark's Wood, Chelsea and Kingsmere as locations. John Macoun (*circa* 1911*) adds four localities of his own, all in Quebec. Three are in the lower Gatineau Valley and one is near Quyon.

MORPHOLOGICAL VARIANT: John Freudenstein (1987) published a preliminary morphological analysis of *C. maculata* showing several differences between early and late blooming plants. These differences include greater lip dilation, floral bract length and number of flowers as well as a broader sepal sinus shape in the early blooming plants. In his forth-coming monograph, Freudenstein (personal communication 1996) will apply the name *Corallorhiza maculata* var. *occidentalis* (Lindley) Ames to these plants. He annotated 20 collections from the District at DAO and CAN, six as var. *occidentalis* and the rest as var. *maculata*. The blooming period for the specimens of the former variety is 3 June to 3 July, while for the latter variety it is 1 July to 28 July. The date of 3 June is two weeks earlier than any other Ottawa District record.

ACYANIC FORM: The long-lived colony discussed above has frequently had a few plants of *C. maculata* var. *maculata* f. *flavida* (C. H. Peck) Farwell since Anne Hanes first told us about them (A. H. Reddoch and J. M. Reddoch 1987b). These plants are much easier to find and count than the typical form because of their bright and distinctive colour (see flower description above). They have usually occurred as isolated individuals and have rarely reappeared close to the site of a previous occurrence. Sometimes no plants of this form were seen for one or two years. Over the two decades, 20 of the 85 stems were f. *flavida*. There have been no other reports of this form in the District.

Forma *flavida* is interesting in that it reveals the yellow pigment that is also present in the typical form. In the typical form, the yellow is mixed with a reddish pigment in varying proportions to give the reds, browns and yellows described above. This reddish pigment can be seen in its pure form in the spots on the white background of the lip of the typical form.

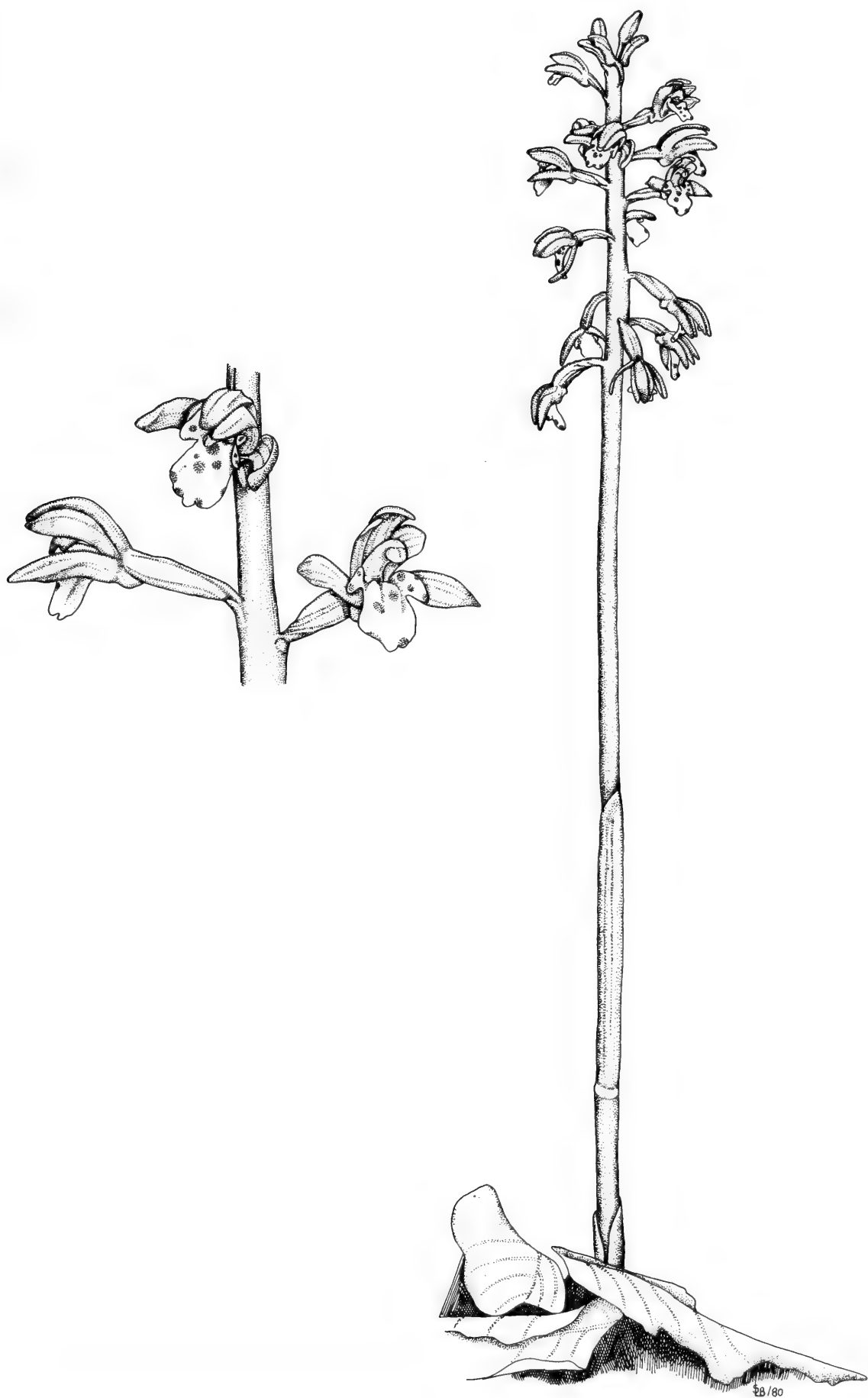


FIGURE 7. *Corallorhiza maculata*, deciduous forest habitat, Gatineau Park, Quebec, 22 July 1973 (plant) and 22 July 1972 (flowers).

Corallorhiza striata Lindley

Striped Coral-root

Corallorhize striée

SYNONYM: *Corallorhiza macraei* A. Gray

Corallorhiza striata is the least abundant of the three *Corallorhizas*. This spring-flowering orchid is widely but thinly distributed in the calcareous areas of the District. It can be recognized by its leafless stem that is not green but some colour in the range pale yellow to orange to ruby and by its striped flowers with boat-shaped, ruby lips.

DESCRIPTION

Height: 4 (12 - 23) 35 cm [115 plants].

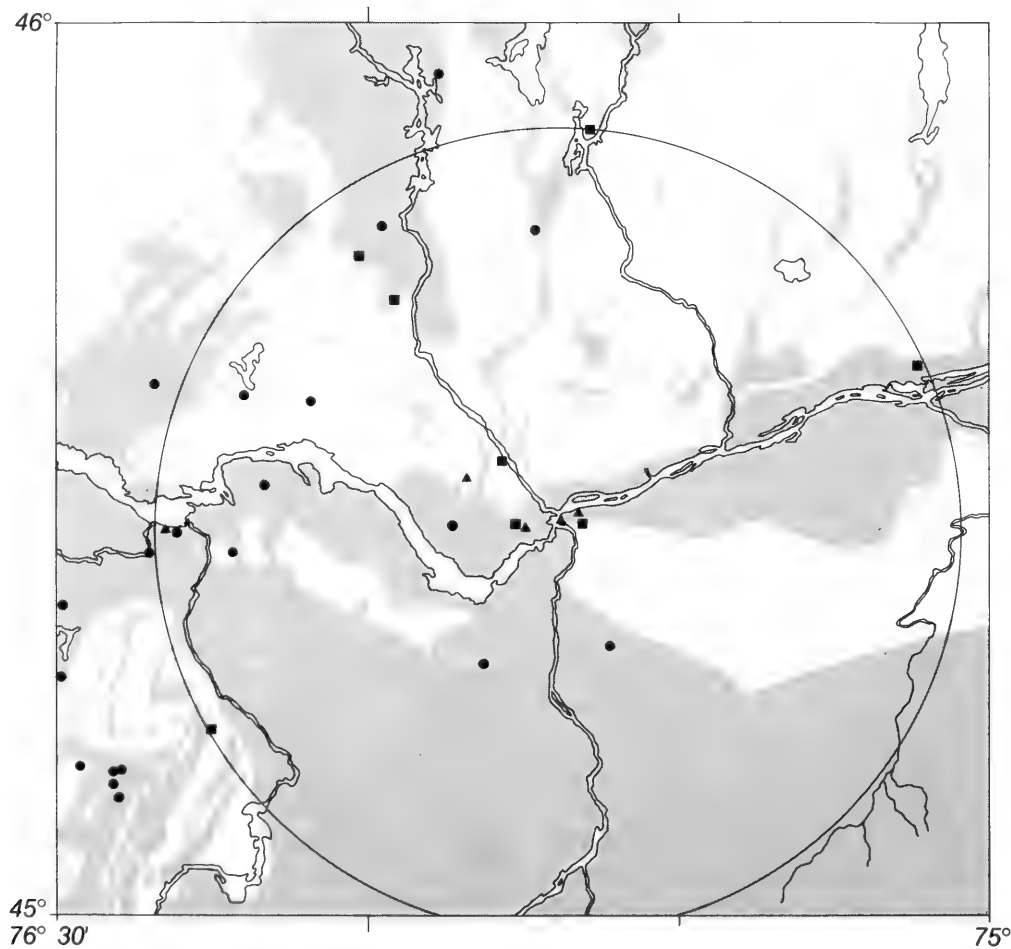
Plant colours: stem ranging from greyish ruby to greyish rose to very pale, e.g., greyish orange (flesh), depending on the amounts of red and yellow pigments, sometimes with decreasing red toward top of stem; sheaths, 1 or 2 above ground, generally paler than stem, e.g., yellowish white with or without fine reddish lines on veins.

Flowers: 2 (8 - 17) 25 [90 plants]; pedicellate ovary and bract light or pale yellow rarely with faint reddish component; sepals and petals with pale yellow to translucent grey or occasionally pale orange

background and dark magenta lines along veins; lip similar but with broader lines of more intense colour, sometimes coalescing to a single mass of colour on outer half, variously ruby, greyish ruby, violet brown or brownish violet; column light yellow or pale yellow usually with a conspicuous reddish spot on underside; fragrance faint, sweet or daisy-like.

Overwintering State: whitish shoots developing below ground at nodes of the coralloid rhizome within a half metre or so of the current year's or recent years' stems.

Capsules: light to medium brown, ellipsoid, typically 2 x 0.6 cm, pendent (see Figure 1a); yield very



Corallorhiza striata: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record, ▲ = literature reference. Major areas underlain by calcareous rock (marble and limestone) are shaded.



FIGURE 8. *Corallorhiza striata*, mixed forest habitat, Gatineau Park, Quebec, 31 May 1969 (plant) and 4 June 1978 (flowers).

low to none (see Long-lived Colony below), although on one occasion in our experience, 100%.

Seeds: pale yellow.

BLOOMING PERIOD: 23 May (27 May - 12 June) 22 June [29 records].

COLONY SIZES: 1 - 155, typically to 30, flowering stems; 3 or fewer in 65% of colonies [18 colonies]; as scattered individuals or in clumps of up to about a dozen stems.

CURRENT STATUS: rare in the Province of Quebec (Bouchard et al. 1983).

DISTRIBUTION: The Ottawa District is within the eastern, Mixed Forest, distribution of this Great Lakes - St. Lawrence and western montane species. Within the District, *C. striata* is thinly scattered in areas of calcareous bedrock on the Shield and on the Lowlands near the Ottawa River.

HABITATS: *Corallorhiza striata* occurs in a variety of mesic, coniferous and mixed forests, as well as in a few cedar swamps.

It grows in partial sun among widely-spaced clumps of Eastern White Cedar on the limestone plains of the southwest and under the deeper shade of Balsam Fir and Eastern Hemlock on the Shield to the north. It is also found in dappled to deep shade in semi-mature and mature mixed forests of such trees as Eastern White Pine, Balsam Fir, Sugar Maple, Beech and Eastern White Cedar. In one forest of just this mix of trees in the upper Gatineau Valley, *Cypripedium parviflorum* var. *pubescens*, *Epipactis helleborine*, *Goodyera tessellata*, and *Platanthera hookeri* were also present. Under a covering of leaf and/or needle humus, the substrate is usually sand, but occasionally it is clay.

A few colonies of *C. striata* have been encountered growing among the mosses or in the wet organic soil of Eastern White Cedar - Balsam Fir swamps.

LONG-LIVED COLONY: In 1968, John Pinder-Moss of Carleton University told us about a colony of *C. striata* that he had just discovered in the southern part of Gatineau Park [CCO 15486]; we have followed its progress since then. (Photographs of plants in this colony were used to prepare the Figure.)

The colony is spread over an area 25 m x 50 m in a maturing Eastern White Pine - Sugar Maple forest that is part of a larger Sugar Maple - Beech forest. Within the colony, the pines average 23 m in height, dbh 40 - 80 cm, and the maples, 19 m in height, average dbh 20 cm. Herbaceous plants at scattered locations on the mesic, sandy forest floor are Jack-in-the-pulpit (*Arisaema triphyllum*), Lady Fern (*Athyrium filix-femina*), Trout Lily (*Erythronium americanum*), Wild Lily-of-the-valley (*Maianthemum canadense*), Red Trillium (*Trillium erectum*), White Trillium (*T. grandiflorum*), White Baneberry (*Actaea pachypoda*), Red Baneberry (*A. rubra*),

Wild Ginger (*Asarum canadense*), Blue Cohosh (*Caulophyllum thalictroides*), Poison Ivy (*Rhus radicans*) and lettuce (*Lactuca* sp.). There are a few plants of *Cornus alternifolia* and a few saplings of Sugar Maple, Black Cherry and Basswood.

There were 60 stems of *C. striata* in 1968 and 155 in 1969. Since then, the number of stems/year has varied between 32 and zero (zero in four non-consecutive years), with an average of seven stems/year.

More detailed mapping in the past 11 years has revealed that most of the stems appearing during that time are confined to five nodes. Three of the nodes are about a metre in diameter and two others measure about 3 m x 7 m. We have found a total of only ten stems outside these nodes (and their positions may define additional nodes).

Within the nodes, stems emerge at intervals of one to five years. The most prolific rhizome has been producing stems for four consecutive years (1993 to 1996). The stems within a node tend to have a similar amount of greyish ruby colour from year to year, while the amount of the colour varies from node to node. From these observations, we infer that the stems at each node derive from a single rhizome system.

This colony is heavily attacked by weevils (*Stethobaris ovata* (LeConte) (Howden 1995)) that cause the stems to dry up soon after flowering; thus the colony rarely produces capsules. This observation leads us to conclude that since so little seed has been produced during the past three decades, the stems appearing during that time likely have come from long-lived rhizomes. Insect or slug activity occurs below ground as well; sheaths on one subterranean shoot examined already showed the holes that are seen on mature stems.

EARLY HISTORY: In 1861 and 1862, John Kerr McMorine collected this orchid at Ramsay, Ontario [QK 12654, 66619, 79687]. Closer to the city of Ottawa, *C. striata* was added to the *Flora Ottawaensis* in 1885 when Miss C. L. Hanington discovered it at New Edinburgh (Whyte, Macoun, and Small 1887; Fletcher 1887). The July 1885 collection by Mrs. Chamberlin at DAO [17709] labelled "Beechwood, Ottawa" presumably records this event. (Mrs. Agnes D. (FitzGibbon) Chamberlin, the daughter of Suzannah Moodie and the niece of Catharine Parr Traill, prepared illustrations of Canadian wildflowers that subsequently appeared in two books with her aunt's text. She was a member of The Ottawa Field-Naturalists' Club from 1880 to 1894.) In 1894, James Fletcher reported that "several plants of this beautiful orchid were collected last spring at Beechwood, and in the woods at the back of Rideau Hall. The first specimen was found by the Hon. Archie Gordon. At the meeting of the Ottawa Electoral District Agricultural Society, on June 5th, a bunch of these flowers was exhibited."

Other nineteenth century collections, in fact all other herbarium collections that we have examined to the present, came from Quebec. James Fletcher (1893) reported "Kingsmere" as an additional location for this "very rare" orchid. John Macoun (*circa* 1911*) listed two additional collections that we have not seen: "Snell Lake, June 15, 1889" by Richard Lee and "one specimen found in the woods east of McKay Lake, June 1902" by Henry St. Jacques. We have not been able to locate Snell Lake.

In 1967, W. G. Dore remembered that participants on an Ottawa Field-Naturalists' Club excursion in May of some year between 1930 and 1933 discovered a colony of *C. striata* "on rocky land under cedars" on the northeast side of Fairy Lake. No specimen was taken. His note describing the event is attached to an unnumbered herbarium sheet at DAO.

Charles Macnamara (*circa* 1940*) stated that he had "not found it so very uncommon around Arnprior".

MISCELLANEOUS: On a number of occasions over a period of years at two sites, we have noticed a black wasp about 2.5 cm long with orange legs visiting *C. striata* inflorescences. We took a wasp to the Biosystematics Research Institute of the Central Experimental Farm where it was identified as *Pimpla pedalis* Cresson (or *Coccygomimus pedalis* (Cresson) Townes and Townes). The wasp has been seen both on plants in bud and in flower, but we do not know what it was doing on these visits. Although it mainly visited the inflorescence, we could see no evidence that it was functioning as a pollinator.

Corallorhiza trifida Chatelain

Early Coral-root

Corallorhiza trifida

SYNONYM: *Corallorhiza innata* R. Brown

Corallorhiza trifida is a widely distributed member of the spring flora in the Ottawa District. It can be recognized as a leafless, early-flowering orchid with greenish sheaths, stem and flowers, the latter with white lips with or without spots.

DESCRIPTION

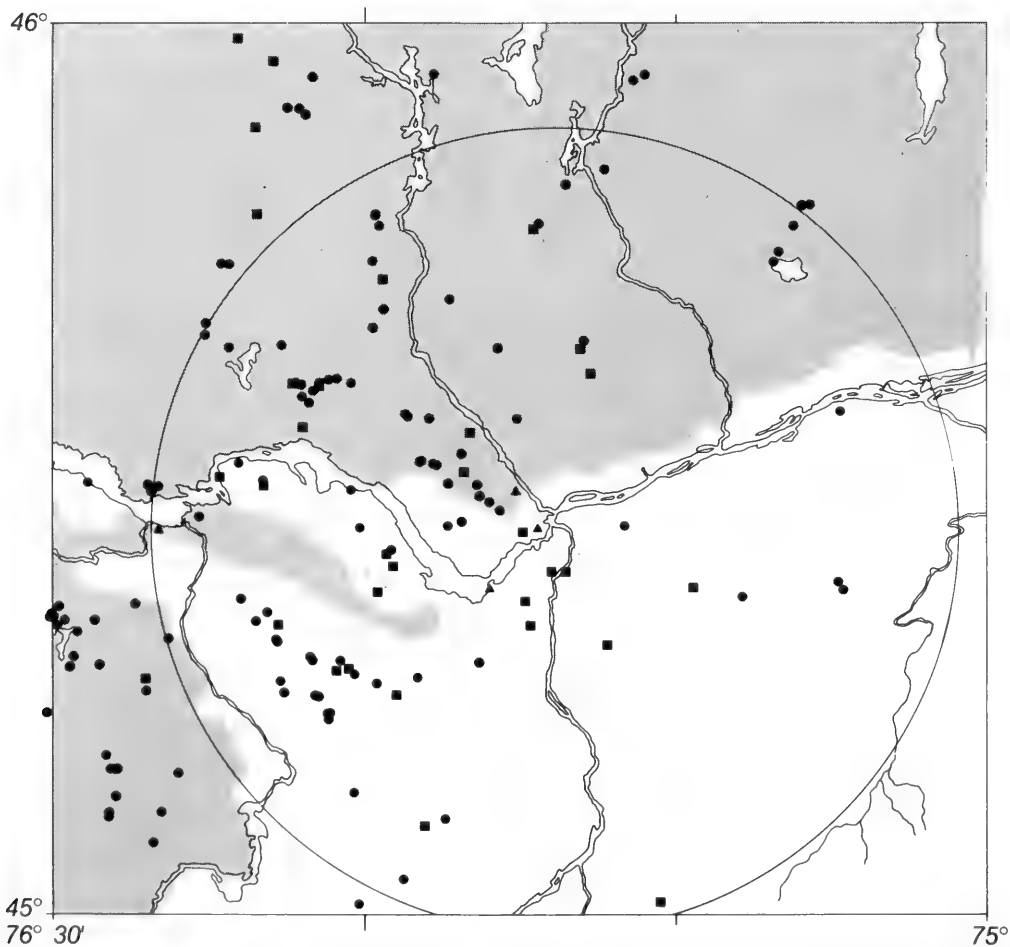
Height: 4 (11 - 21) 32 cm [189 plants].

Plant: stem greyish green; sheaths 1 or occasionally 2, similar in colour to stem, often with brownish tips in typical variety. Its lack of leaves in mature plants and its coralloid root are usually regarded as evidence of a dependence on mycorrhiza; however, spectroscopic studies have shown the presence of some chlorophyll, and physiological studies have shown that some photosynthesis also occurs (as summarized by Freudenstein and Doyle 1994).

Flowers: 2 (4 - 11) 15 [101 plants]; sepals and petals greyish green similar to stem and sheaths or sometimes more yellowish, lip white; in the typical variety: column, upper and lower surfaces of lip and

of petals with deep magenta or ruby spots, sepals often with brownish tips and petals with lighter brown tips; occasionally, brownish colour absent from tips of sepals and petals, and spots on lip small and restricted to base, a variation also reported by Case (1984) from the north shore of Lake Superior; in var. *verna* (see Acyanic Form below): red and brown colorations absent; odour faint and acrid or richly floral, or lacking.

Overwintering State: in swamps: several or many pale green shoots, 4 mm in diameter, 1.5 - 2.5 cm tall, about 4 cm down in the moss substrate, rising from nodes of coralloid rhizomes several centimetres from the current year's stems, by early fall; in forests: shoots likely in a similar state below ground.



Corallorhiza trifida (both varieties): ■ = herbarium specimen, ● = Native Orchid Location Survey sight record, ▲ = literature reference. The Canadian Shield is shaded.

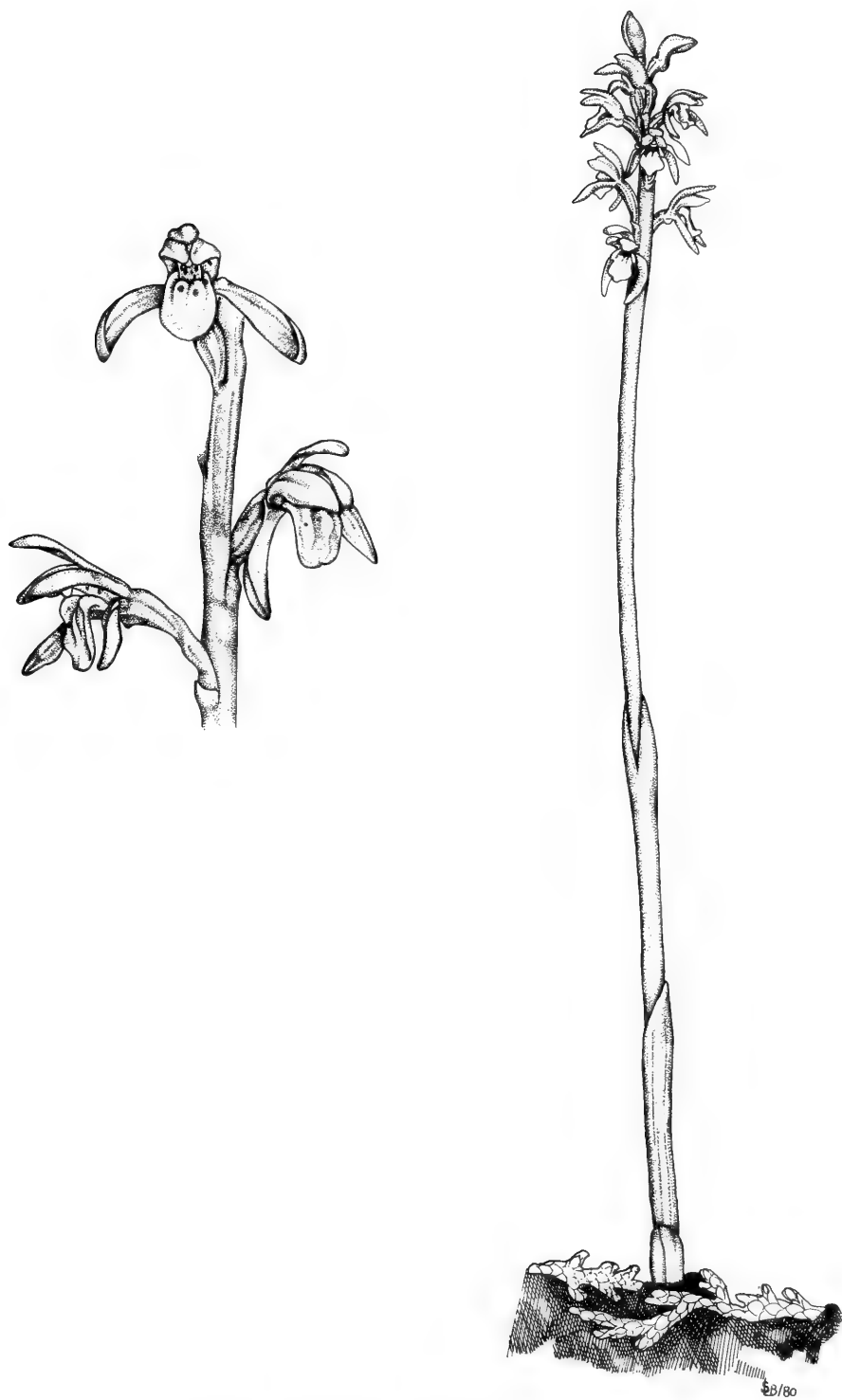


FIGURE 9. *Corallorhiza trifida* var. *verna* (plant): deciduous forest habitat, Gatineau Park, Quebec, 19 May 1968; *C. trifida* var. *trifida* (flowers), cedar swamp habitat, West Carleton Township, Regional Municipality of Ottawa-Carleton, Ontario, 24 May 1975.

Capsules: brown, ellipsoid, typically 1 x 0.5 cm, pendent (see Figure 1a); yield depending on habitat: clumps in swamps approaching 100%, scattered individuals in woodlands often very low; previous year's stems persisting well into the next season.

Seeds: brownish orange, released in late September.

BLOOMING PERIOD: 12 May (25 May - 14 June) 23 June [55 records].

COLONY SIZES: 1 - 200, typically to 50, flowering stems; 10 or fewer in 69% of colonies [139 colonies]; the large colonies occur in swamps: one exceptional colony with 2500 flowering stems in West Carleton Township cedar swamp in 1969 (Hue MacKenzie, personal communication); as clumps of typically 20 stems in swamps and as scattered individuals in woodlands.

DISTRIBUTION: The Ottawa District is well within the North American range of this orchid. It is a transcontinental species of the Boreal and Mixed Forest Regions and adjacent regions of the Montane and Deciduous Forests and Tundra. Within the District, *C. trifida* is widely distributed except in the southeast.

HABITATS: Various swamps, treed fens and mesic forests harbour this orchid in the Ottawa District. These habitats provide adequate moisture and dappled to deep shade.

Corallorhiza trifida is frequent in swamps, especially those dominated by Eastern White Cedar and accompanied by a selection of Black Spruce, White Spruce, Tamarack, Black Ash and Yellow Birch. In the open or sometimes under ferns or the lower branches of conifers, the orchids grow in moist or wet organic soil or among mosses. Typical companion species in more open swamps are Cinnamon Fern (*Osmunda cinnamomea*), Jack-in-the-pulpit (*Arisaema triphyllum*), Bluebead-lily (*Clintonia borealis*), *Cypripedium reginae*, *Malaxis monophylla*, *Platanthera hyperborea*, Naked Mitrewort (*Mitella nuda*), Foamflower (*Tiarella cordifolia*) and One-flowered Wintergreen (*Moneses uniflora*). Treed fens and stream edges are other wet environments inhabited by this orchid.

Some deciduous, mixed and coniferous forests are also suitable habitats for *C. trifida*. Sugar Maple - Beech, Sugar Maple - Beech - Eastern Hemlock - Eastern White Pine, Eastern White Pine - Red Maple, Eastern Hemlock - Balsam Fir and Eastern Hemlock - Eastern White Cedar are some of the common mesic forest types. Dense, dryish Eastern White Cedar thickets sometimes also shelter this orchid. The substrates are usually sands and sandy loams.

LONG-LIVED COLONY: A colony that we have noticed from time to time since 1968 in Gatineau

Park is at the edge of a seasonal pond under a canopy of Yellow Birch, Eastern Hemlock and Red Maple. The plants grow in wet, partially-decayed leaf-litter close to the high water line. In 1968 there were a dozen flowering stems. The number of flowering stems has varied over the years from 15 (in 1996) to none in some years. There was one flowering stem in 1995. It is possible that coralloid rhizomes are long-lived and put up flowering stems under favourable conditions for many decades.

EARLY HISTORY: James Fletcher collected *C. trifida* at "Billings Bridge, Nr. Ottawa" on 21 May 1877 and 12 May 1878 from "damp meadow at edge of wood" [both on one sheet, DAO 17733]. Other nineteenth century collections came from Dow's Swamp [at CAN, MTMG and TRT] and Beaver Meadow near Hull [at MTMG and TRT]. Among the specimens cited by John Macoun (*circa* 1911*) is a Robert B. Whyte collection from "Swamp at Lake Flora. Hull" on 24 May 1878 and one of his own "in woods at Britannia 1903". The whereabouts of these collections are unknown. James Fletcher (1893) considered this orchid to be "rather rare" in the District.

This species and *Galearis spectabilis* were the two representatives of the orchid family gathered during an Ottawa Field-Naturalists' Club excursion to Ironsides, Quebec, on Saturday, 23 May 1909 (Halkett 1909).

ACYANIC FORM: *Corallorhiza trifida* var. *verna* (Nuttall) Fernald differs most notably from the typical plant in lacking the red and brown colorations (see descriptions of plant and flowers above). The whole plant except the lip is greyish green or sometimes more yellowish; the lip is white without spots.

This variant is more common in the southern part of the range of the species (Luer 1975). The two variants are about equally abundant in the District and sometimes grow adjacent to each other in swamps. *Verna* is the variant generally found in mesic forest habitats.

Nuttall (1823) and Fernald (1946) each describe morphological differences in the sepals, petals and lip between var. *verna* and the typical plant, in addition to the colour differences. Some recent authors ignore the morphological differences, but John Freudenstein (personal communication 1996) believes that they are real although not yet well understood. In the District, we do not find these morphological differences to be significant or to correlate with the colour differences.

If the only difference were the obvious colour difference, it would be appropriate to reduce the rank of var. *verna* to that of a form. However, it would be premature to do so until the nature and significance of the morphological variation throughout the range of the species are established.

Cypripedium acaule Aiton

Pink Lady's-slipper
Stemless Lady's-slipper

Cypripède acaule
Sabot de la vierge

This species is a showy and abundant orchid that inhabits a variety of shaded, acidic habitats, both wet and dry. It is easily recognized by its mostly pinkish lip with a longitudinal slit and its pair of basal, ascending, strongly ribbed leaves.

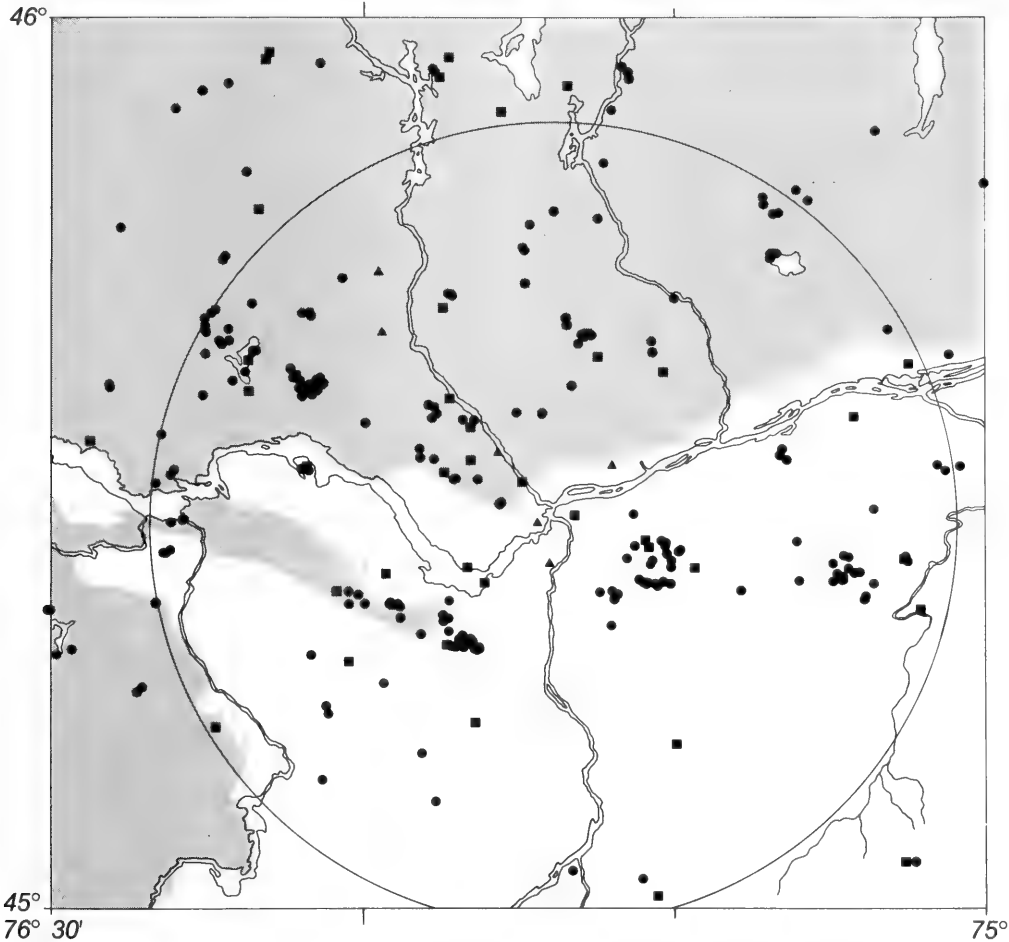
DESCRIPTION

Height: 10 (18 - 36) 59 cm [231 plants].
Flower: one, often greyish magenta but varying from pink to ruby to brownish violet, the colour usually more intense on the veins; sepals and petals usually darker than lip, greyish ruby but occasionally light or reddish brown; lateral sepals fused but sometimes with a slight double tip; petals and interior of lip near column with long dense pubescence that is mostly colourless but pinkish or reddish near central areas; staminode white, green and brown in varying proportions; in f. *albiflorum* (see Acyanic Form below): lip and staminode white, sepals and petals yellowish green; fragrance usually pleasantly floral, varying in intensity from quite strong to none, sometimes with sharp notes.

Leaves: 2 on flowering plants, 1 or 2 on non-flowering plants.

Overwintering State: one or more, greyish green, broadly conical shoots, 1 - 2 cm above ground beside the current year's stem, appearing in late September.

Capsule: brown, ellipsoid, typically 3 x 1 cm, somewhat ascending, persisting to following year with conspicuous remains of flower (unfertilised flowers dehiscent); yields from 10% to 40%, occasionally higher, averaging 30% [474 plants]; these yields, from eight counts at five different sites over a number of years, are notably higher than the percentages reported elsewhere for pollen mass removal, flower pollination and fruit set, which are generally less than about 12% (Plowright, Thomson, and Thaler 1980; Davis 1986; Primack and Hall 1990; Gill 1996).



Cypripedium acaule: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record, ▲ = literature reference. The Canadian Shield is shaded; areas underlain by sand and sandstone have been omitted for clarity.

Seeds: greyish yellow, released in early to mid October.

BLOOMING PERIOD: 18 May (29 May - 16 June) 4 July [105 records].

COLONY SIZES: 1 - 1500, typically to 250, flowering and non-flowering plants [273 colonies], mostly as scattered individuals but with some clumps of up to about a dozen flowering stems, in all habitats.

CURRENT STATUS: one of the most abundant orchids in the District.

DISTRIBUTION: The Ottawa District is well within the range of this mainly Great Lakes - Appalachian - Atlantic Coast species of the Mixed Forest Region and adjacent Deciduous and Boreal Forests. Within the District, *C. acaule* is widespread across the Canadian Shield and the Lowlands. It occurs in wetlands and in areas of acidic rocks and of sands left by the Laurentide ice sheet, the Champlain Sea and subsequent rivers.

HABITATS: Many wet, moist and dry sites provide suitable habitats for this orchid, as long as they are acidic and at least partially shaded.

Old bogs and swamps are the usual wet-mesic habitats. Colonies of *C. acaule* grow in *Sphagnum* moss in old bogs. The plants occur among ericaceous shrubs or with little other ground cover, in bog forests of Black Spruce and Tamarack or near groves of these trees in more open bogs (and among scattered Grey Birch east of the Rideau River). In areas of calcareous bedrock, plants are found occasionally in semi-open Eastern White Cedar - Black Spruce - Tamarack fens and swamps. Here they live above the wetland floor in the more acidic conditions of hummocks and wetland margins. Rarely there are a few plants in seepage areas in otherwise mesic forests.

Mesic coniferous, mixed and deciduous forests on deep sand and in shallow soil over acidic rocks furnish suitable habitats for *C. acaule*. Red Pine plantations are common habitats as are forests of Eastern White Pine, in pure stands or mixed with other trees such as Red Maple, Sugar Maple, Red Oak, Trembling Aspen and Grey Birch. Familiar species growing with *C. acaule* in the needle or leaf humus are Bristly Clubmoss (*Lycopodium annotinum*), Bracken (*Pteridium aquilinum*), Bluebead-lily (*Clintonia borealis*), Wild Lily-of-the-valley (*Maianthemum canadense*), Starflower (*Trientalis borealis*) and Twinflower (*Linnaea borealis*). A Red Oak - Trembling Aspen - Jack Pine - Red Pine forest on old dunes beside the Ottawa River at Constance Bay also shelters *C. acaule*.

Precambrian knolls and hilltops are typical dry sites. Plants grow in shallow soil and humus among lichens, *Polytrichum* mosses and Bracken, rarely in grasses, around trees and in open woods.

Comparable dry conditions are provided by sandstone flats on the Lowlands.

LONG-LIVED COLONIES: Individual plants of *C. acaule* may live for many decades and colonies may last for even longer.

In the Larose Forest, the large colonies already well established in 1969 in 40-year-old Red and Scots Pine plantations (see also Dore 1969), remain to the present (1996). Numbers have dwindled where a picnic ground was installed and where the trees have been so well trimmed that there is more light and, consequently, increased ground cover. Plants of *Malaxis unifolia* and *Spiranthes lacera* often accompany *C. acaule* on the needle-strewn plantation floor.

The Eastern White Pine forest and its colony of *C. acaule* at Blueberry Point near Aylmer, Quebec, were presumably already of considerable age when first visited by naturalists at the turn of the century. Herbarium collections of *C. acaule* record the existence of the colony between 1905 [CAN 116907] and 1948 [Breitung 6421 at DAO].

EARLY HISTORY: The earliest known collection of *C. acaule* was made in 1862 by John Kerr McMorine at Ramsay, Ontario [QK 2681]. Around the turn of the century, this species was known from many locations, in both wetlands (Fletcher 1893; Whyte, Craig, and Macoun 1897; Fyles 1912) and forest habitats.

Plants were regularly sought on Ottawa Field-Naturalists' Club excursions to Gilmour's Grove on the Gatineau River at Chelsea, Quebec (Ami 1896; Clarke 1904, 1908; Reddoch 1979b) and evidently were collected enthusiastically by many of the 200 naturalists and student teachers who attended. In 1908 Clarke reported that "Dr. Fletcher ... deprecated the digging up of the roots of [*C. acaule*] which could not be cultivated [like the other species mentioned]. Through this useless destruction the plant is now very rare here".

Earlier, Whyte, Craig and Macoun (1897) urged the preservation of our wild flowers because many populations were disappearing, including "*C. acaule* [which] is not to be found in Dow's Swamp, where it was formerly abundant ...".

ACYANIC FORM: *Cypripedium acaule* f. *albiflorum* Rand and Redfield, which is quite common in New Brunswick (Hinds 1986), Nova Scotia (Roland and Smith 1969), New Hampshire (Brackley 1985) and Quebec (Ed Greenwood, personal communication 1996) but uncommon elsewhere, has been collected, photographed or reported at least nine times in the Ottawa District (A. H. Reddoch and J. M. Reddoch 1987b). From one to a dozen such plants occur, either as individuals or in clumps, within larger colonies of typical plants. The white-flowered plants persist for several years. One colony, in Huntley Township west of Stittsville growing in an area 10 m across on sand under Eastern White Pine, had sever-

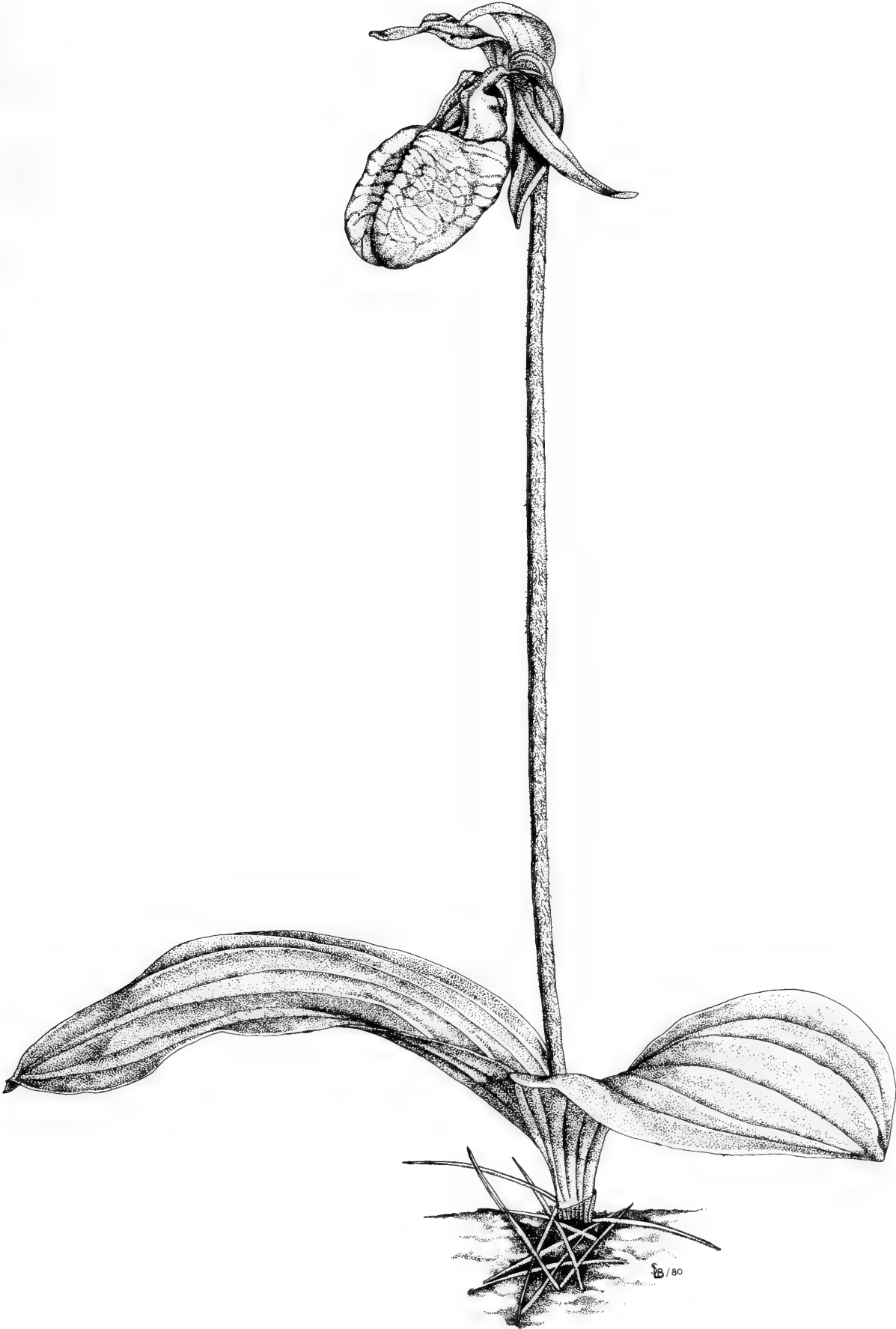


FIGURE 10. *Cyripedium acaule*, mixed forest on sandstone, Stony Swamp Conservation Area, Regional Municipality of Ottawa-Carleton, Ontario, 15 June 1980.

al of these flowers, along with typical ones, for at least 13 years. In the Larose Forest, we have seen one or a few white flowers at various times over a period of 30 years, but these random sightings have involved different plants.

These striking flowers, lacking the magenta anthocyanin, have a lip that is pure white, except for pale green outside near the ovary, and a variable mixture of green and yellow on the sepals, petals and staminode. Close inspection may show a faint reddish blush on the staminode, ovary and adjacent parts that arises from a pigment on the tips of the glandular hairs. As discussed in the Introduction, the green and yellow colours seen in the acyanic form combine with anthocyanin to produce the characteristic brown or greyish magenta hues of the normal flower.

ABERRATIONS: *C. acaule* seems to have more structural aberrations than the other Lady's-slippers. In one plant that might be called scapeless, the lip, tepals and floral bract all pointed upwards at ground level from between a pair of leaves no larger than these floral parts. Another short plant, in which the flower had aborted at an early stage, produced a scape about two cm long, so that the green floral bract was leaning on one of the leaves.

One collection from the Ottawa District [Senn 1463 at NA] is of a plant with two flowers on separate scapes. A different type of two-flowered plant, seen in the field, had the flowers on a single scape, the lips being joined back-to-back in a manner similar to that reported from New Hampshire (Brackley 1985).

We observed a different type of aberration in a plant bearing one extra tepal. This was outside a petal and perhaps partly fused to it. It was boat shaped, about the size of the lip, pink veined on the outside and mostly white on the inside, looking somewhat like a half lip. On another plant, a more deformed flower with a possibly related aberration had only half a lip and it was fused to the opposite petal. It also had one normal petal and normal sepals. The column was outside the twisted lip-petal and had only the stigmatic surface and one pollinium, lacking the staminode.

DEVELOPMENT: As the buds begin to open, the scape is still arched over with the flowers pendent. The lips are almost white, suggesting f. *albiflorum*, but the colour intensifies as the flowers develop.

In large colonies, some 20% to 35% of the plants are flowering, 35% to 65% are non-flowering with two leaves and 15% to 40% are non-flowering with only one leaf.

Some of the variation in the height of flowering plants arises from the continuing growth of the scapes during anthesis, about five mm per day. This growth can be seen in the way that the previous year's capsules tower over the flowering plants until near the end of the flowering period.

DERMATITIS: The floral bract and perhaps other parts of this *Cypripedium* occasionally cause allergic reactions in susceptible people (Reddoch and Reddoch 1984), but the effects are not as severe as from *C. parviflorum* and *C. reginae*.

Cypripedium arietinum R. Brown

Ram’s-head Lady’s-slipper

Cypripède tête-de-bélier

Cypripedium arietinum is the smallest, least conspicuous, least common and hence least familiar of our Lady’s-slippers. When in bloom, it is easily identified by its small, purplish flower with its uniquely-shaped lip. In contrast to our other Lady’s-slippers, the lateral sepals are not united. The leaves differ from those of the other species in being relatively small and narrow and in being arranged in a rough spiral about the stem.

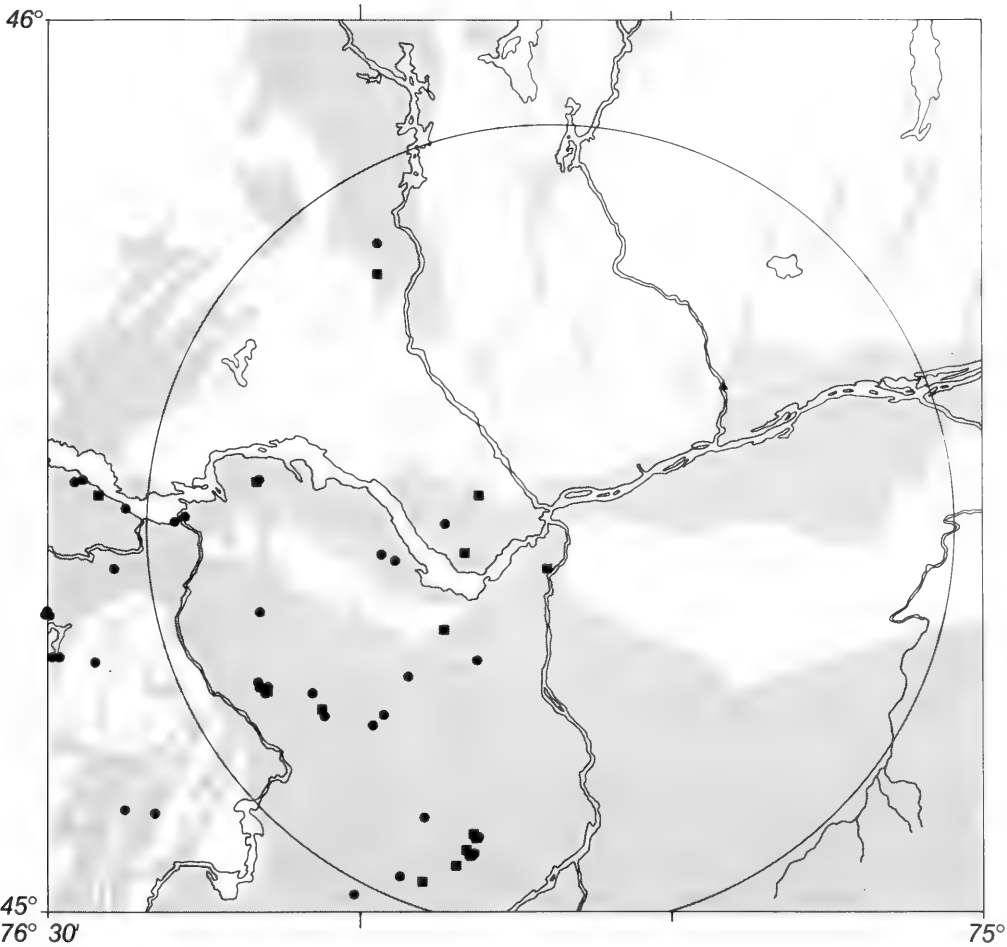
DESCRIPTION

Height: 11 (16 - 26) 34 cm [224 plants].
Flower: 1, rarely 2; lip a small conical cup, the opening formed by a circular inrolled edge surrounded by numerous white bristles, with several transparent windows in sides, essentially white with pale yellowish green or greyish magenta at the apex and greyish magenta, deep magenta or greyish ruby as stripes centred on a set of vertical veins and irregular cross veins on the front and sides, and as narrow, vertical, parallel, equally spaced lines on the back; staminode convex above with a marked central, vertical groove; lateral sepals and petals narrow, reddish or violet brown, occasionally as stripes on a yellowish green background; in f. *albiflorum* (see Acyanic Form below): lip white with yellowish

green on basal apex, sepals and petals yellowish green; fragrance sweet, floral or vanilla-like, of quite variable intensity.
Leaves: 3 - 4, deep green (but not, as described by some authors, bluish green); 3 - 4 on non-flowering plants.

Overwintering State: one or more, pale green, conical shoots, appearing at ground level beside the current year’s stem in early October.

Capsule: brown, ellipsoid, typically 1.7 x 0.7 cm, ascending (see Figure 1a; unfertilized flowers dehiscent); yields from 30 to 90%, the higher values associated with more open habitats [760 plants]; some capsules attacked by weevils (*Stethobaris ovata* (LeConte) (Howden 1995)) before seed release.



Cypripedium arietinum: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record, ▲ = literature reference. Major areas underlain by calcareous rock (marble and limestone) are shaded.

Seeds: greyish orange, beginning to release in early to mid October.

BLOOMING PERIOD: 16 May (24 May - 7 June) 16 June [48 records].

COLONY SIZES: 1 - 1000 plants, typically to 120, flowering and non-flowering plants [45 colonies], occurring as scattered individuals and in clumps of up to 6 stems; wetland colonies restricted to a few scattered individuals; about 50% of plants bearing flowers [800 plants].

CURRENT STATUS: rare to uncommon (S3) in Ontario (Active List, Oldham 1996*), rare in the Province of Quebec (Bouchard et al. 1983).

DISTRIBUTION: The Ottawa District is near the northern edge of the range of this mainly Great Lakes - St. Lawrence orchid of the Mixed Forest Region.

In the District, this species is confined to regions underlain by limestone on the Lowlands and by marble on the Shield. *Cypripedium arietinum* is known only west of the Rideau and Gatineau Rivers, with particular concentrations in the southwest where the limestone of the Smith Falls Limestone Plain (Chapman and Putnam 1984) is close to the surface.

HABITATS: *Cypripedium arietinum* occurs in two different types of habitats, one dry to moist and the other moist to wet.

The first habitat is provided by maturing coniferous forests in areas of shallow soil over flat-lying calcareous rocks, including alvars (Catling and Brownell 1995). Eastern White Cedar is usually the dominant tree, often accompanied by White Spruce and Balsam Fir. Trembling Aspen and other deciduous trees are sometimes present. Plants grow in the dappled to partial shade of small to large openings in the forest canopy. Ground cover is usually sparse and often includes Poison Ivy (*Rhus radicans*) and Gaywings (*Polygala paucifolia*), the latter in flower at the same time as the orchid. *Cypripedium parviflorum* var. *pubescens* is a constant companion in more open sites.

A few scattered plants occasionally are found in the moist to wet conditions of semi-open Eastern White Cedar - Black Spruce - Tamarack fens and the edges of cedar swamps. Plants sometimes are drowned by rising water levels in the latter habitat.

LONG-LIVED COLONIES: Some locations are known to have provided stable habitats for *C. arietinum* for many decades.

Chilcott's Swamp, near Alcove, Quebec (Fyles 1912), has been a known location for *C. arietinum* at least since John Macoun collected it there in 1898 [TRT 15391]. In 1992, André Sabourin (personal communication) found 22 plants there.

Near Braeside, Ontario, the dry, sandy, shallow soil under White Spruce and Eastern White Cedar supports thousands of plants over a wide area of the

limestone plain (Adolf Vogg, personal communication 1994). Charles Macnamara (*circa* 1940*) described the orchids and their habitat there in the early years of this century. This spectacular alvar population is currently threatened by estate lot development.

In The Burnt Lands Alvar, several hundred plants of *C. arietinum* and about half as many of *C. parviflorum* var. *pubescens* have flourished since at least 1968. The plants grow in shallow, clayey soil (pH 7.5) over limestone bedrock in open, partially shaded clearings among widely-spaced Eastern White Cedar, White Spruce, Balsam Fir, Trembling Aspen and Balsam Poplar. The diverse but sparse ground cover includes some grasses and Wood Lily (*Lilium philadelphicum*), Wild Lily-of-the-valley (*Maianthemum canadense*), Star-flowered False Solomon's Seal (*Smilacina stellata*), *Malaxis unifolia*, *Spiranthes lacera*, Barren-strawberry (*Waldsteinia fragarioides*), Cooper's Milk-vetch (*Astragalus neglectus*), Gaywings, Poison Ivy, Bearberry (*Arctostaphylos uva-ursi*), Spurred-gentian (*Halenia deflexa*) and Large-leaved Aster (*Aster macrophyllus*).

The Marlborough Forest shelters several large colonies of *C. arietinum*. In one colony that we first encountered in 1981, the plants are clustered in scattered glades of dappled sun beneath mature Eastern White Cedar with White Spruce and Balsam Fir. Ivory Sedge (*Carex eburnea*) and Wild Lily-of-the-valley often accompany *C. arietinum* in the black, moist needle-mould of this more shaded habitat. Clear-cutting along the southern edge of this colony in 1995 wiped out all of the plants in that section. In 1996, Don Cuddy (personal communication) and members of the Ontario Ministry of Natural Resources' Environmental Youth Corps Program sampled the population and estimated a concentration of 1375 plants per hectare in the vicinity of this colony. They estimated that there are about 750 ha of suitable habitat on public land in the forest. This may be the highest concentration of this species on public land in Ontario.

EARLY HISTORY: *Cypripedium arietinum* was added to the *Flora Ottawaensis* in 1882 when it was discovered in Dow's Swamp "in great profusion within a limited area" (Fletcher 1883; Whyte and Small 1883). James Fletcher made collections on 12 June of that year [MTMG 25532 and US 27620]. Although recognized as very rare in the District (Fletcher 1896), this orchid was collected a number of times at the same place between 1883 and 1906 (see, for example, Fletcher, Scott, and Cowley 1892).

Until the 1950s, this species was known only from Dow's Swamp, Chilcott's Swamp and from near Aylmer, Quebec, as well as at Braeside (see Long-lived Colonies above). In 1952, several colonies



FIGURE 11. *Cypripedium arietinum*, mesic cedar forest habitat, City of Nepean, Regional Municipality of Ottawa-Carleton, Ontario, 31 May 1971.

were found in open, mixed woods and adjacent cedar woods near Fitzroy Harbour, Ontario (Calder 1952).

ACYANIC FORM: One plant of *Cypripedium arietinum* f. *albiflorum* House was photographed by Michael Runtz (1994; personal communication 1995) near Braeside, Ontario, in the Study Area beyond the 50-km circle. The description above is based on this photograph.

ABERRATIONS: Only one two-flowered plant has been seen in the District. One other plant had a "Siamese twin" flower that had two fused lips, one column, four sepals (9 mm long), three petals (2, 4 and 6 mm long) and a large floral bract (6 cm long).

DERMATITIS: Contrary to our expectations (Reddoch and Reddoch 1984), we have found no evidence for dermatitis from this species.

***Cypripedium parviflorum* Salisbury var. *pubescens* (Willdenow) Knight**
***Cypripedium parviflorum* Salisbury var. *makasin* (Farwell) Sheviak**

Yellow Lady's-slipper

Cypripède jaune

SYNONYMS: *Cypripedium calceolus* Linnaeus var. *pubescens* (Willdenow) Correll, *C. calceolus* Linnaeus var. *parviflorum* (Salisbury) Fernald, *C. pubescens* Willdenow.

This is one of our most distinctive and abundant orchids, occurring in a variety of calcareous habitats and showing considerable variation in flower size and colour. It can be recognized in flower by its yellow lip and otherwise by its cauline leaves that are two-ranked rather than spiralled about the stem.

TAXONOMY: We follow the concepts of Sheviak (1993, 1994, 1995), who recognizes the North American *C. parviflorum* as a species distinct from the European *C. calceolus*. He proposes two varieties in the northern part of the range, the highly variable var. *pubescens* (Willdenow) Knight and the small-flowered var. *makasin* (Farwell) Sheviak. He distinguishes them by differences in flower size, colour distribution on sepals and petals, fragrance and amount of pubescence on the upper sheathing bract (Sheviak 1994).

The majority of the plants in the District are referable to var. *pubescens* and it is these plants that we describe below. Some of the plants in a few cedar swamps and fen edges that have small flowers with very dark, uniformly coloured sepals and petals, and intense, sweet fragrance may be referable to var. *makasin*.

DESCRIPTION

Height: 12 (23 - 41) 57 cm [328 records].

Flowers: 1, occasionally 2 (one above the other with the lower having a larger floral bract); lip 2.6 - 4.5 cm long, yellow (sometimes light, vivid or dark yellow) with red or brownish red spots in rows within and sometimes irregularly along edge of orifice; sepals and petals ranging from greyish or yellowish green with narrow reddish brown lines along veins, through reddish, dark or violet brown as rows of dots or lines of variable width to a nearly uniform field of these colours; lateral sepals united with distinctly split apex; petals usually corkscrewed with 3 - 5 half turns, less commonly 0 - 2 or with a wavy edge; staminode similar in colour to lip or slightly more intense, with reddish spots usually in two rows near edges but occasionally irregular or as lines, and often with a green or deep green line along centre line; fragrance variable in character and intensity: rose, raspberry, strawberry, lilac or vanilla.

Leaves: 3 - 4, less commonly 5, two-ranked, the lowest often the smallest; 3 - 4 on non-flowering plants.

Overwintering State: one or more, greyish green, broadly conical shoots, 0 - 2 cm above ground beside the current year's stem, appearing in late September, or pale green, remaining below ground level until spring.

Capsules: brownish orange to light brown, ellipsoid, typically 2.6 x 1 cm to 3.7 x 2 cm, ascending; yield highly variable from colony to colony and year to year from very small to about 50%, rarely to 80%; 32% and 9% in 1990 and 1991, respectively, in a Gatineau Park study (Tremblay 1994);

Seeds: light brown, released in early to mid October.

BLOOMING PERIOD: 9 May (27 May - 18 June) 6 July [142 records].

COLONY SIZES: 1 - 835, typically to 125, flowering and non-flowering plants [257 colonies]; singly and in clumps of up to about 20 stems; one clump just south of Stony Swamp Conservation Area about 80 cm across with about 75 flowering stems in 1969, declining to about 30 flowering stems four years later.

CURRENT STATUS: one of the most abundant orchids in the District.

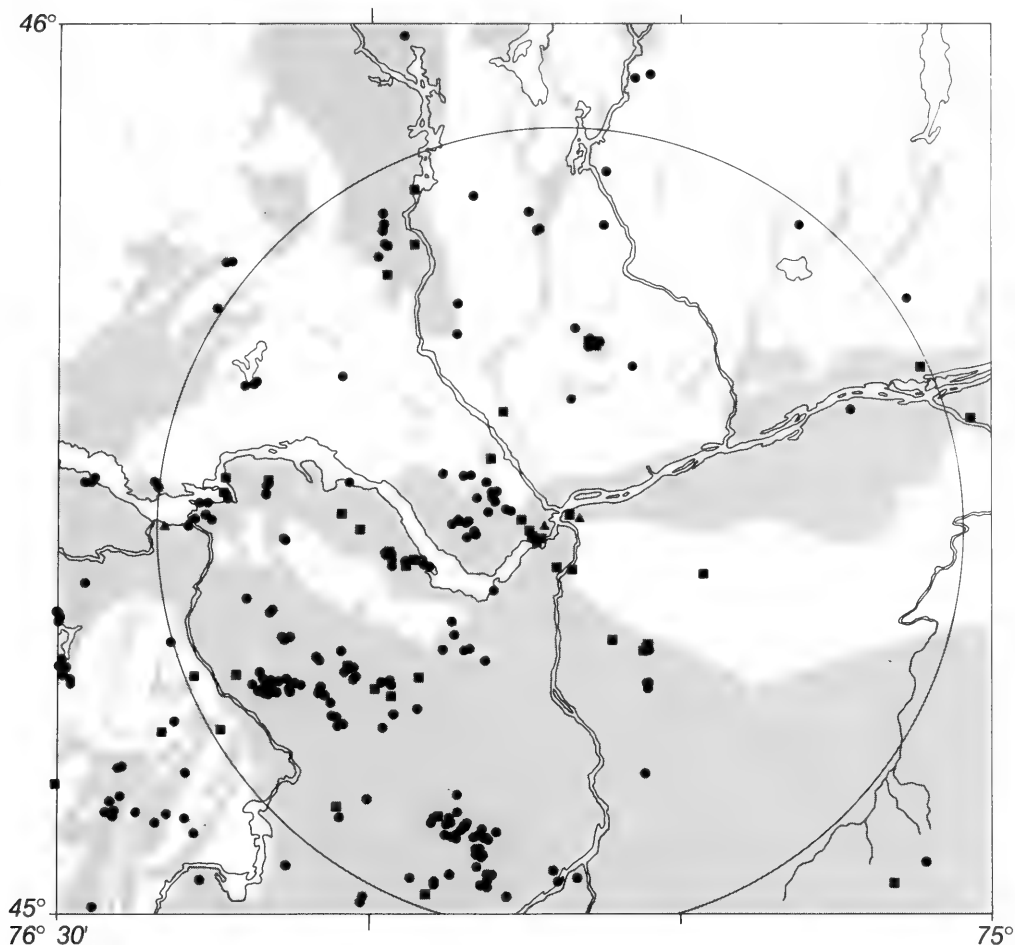
DISTRIBUTION: The Ottawa District is in the north-eastern part of the continental distribution. This is an orchid of the Montane, Boreal, Mixed and Deciduous Forest Regions and adjacent northern Prairie.

Within the District, *C. parviflorum* is widely scattered across the Canadian Shield and more concentrated on the Lowlands west of the Rideau River. It occurs in areas underlain by Precambrian marble and other calcareous rocks.

HABITATS: *Cypripedium parviflorum* occupies a wide range of habitats in calcareous regions. In wetlands, it commonly occurs in wet-mesic, partially-shaded openings and edges of coniferous and mixed swamps. These swamps are treed with various combinations of Eastern White Cedar, Tamarack, White Spruce, Black Spruce, Balsam Fir, Trembling Aspen, Black Ash and Red Maple. The herbaceous layer often includes Bulblet Fern (*Cystopteris bulbifera*), Crested Wood Fern (*Dryopteris cristata*), Bluebeadlily (*Clintonia borealis*), Wild Sarsaparilla (*Aralia nudicaulis*), Bunchberry (*Cornus canadensis*) and Starflower (*Trientalis borealis*).



FIGURE 12. *Cypripedium parviflorum* var. *pubescens*, alvar habitat, West Carleton Township, Regional Municipality of Ottawa-Carleton, Ontario, 27 May 1979.



Cyripedium parviflorum (both varieties): ■ = herbarium specimen, ● = Native Orchid Location Survey sight record, ▲ = literature reference. Major areas underlain by calcareous rock (marble and limestone) are shaded.

Cyripedium parviflorum is also found at the semi-open transition zone between open fen and swamp among Eastern White Cedar, Black Spruce and Tamarack and accompanied by typical fen vegetation. The sedge peat mat is usually consolidated; rarely, it is floating (Adolf Vogg, personal communication 1988).

Mesic to dry woodlands are other common habitats for *C. parviflorum*. These woodlands may be coniferous, mixed or deciduous with almost any combination of trees, but they have in common that they are usually relatively open, either because they are young to semi-mature or because they contain large clearings. The soil may be rich with humus (sometimes in rocky crevices) or shallow and clayey over flat-lying bedrock. The herbaceous layer in rich deciduous woods often includes Rattlesnake Fern (*Botrychium virginianum*), Maidenhair Fern (*Adiantum pedatum*), Wild Onion (*Allium canadense*), Trout Lily (*Erythronium americanum*), White Trillium (*Trillium grandiflorum*) and Bellwort (*Uvularia grandiflora*).

Limestone plains and alvars are also typical habitats for *C. parviflorum*. Plants grow in shallow soil

in the open sun or in the partial shade of conifers. See The Burnt Lands Alvar in the Long-lived Colonies section of the *C. arietinum* account for further details of this habitat.

LONG-LIVED COLONIES: *Cyripedium parviflorum* is a long-lived plant. Its colonies can persist for decades wherever the habitat is stable. For example, the colonies in Chilcott's Swamp first recorded in 1911 (Fyles 1912, collections at DAO) were still extant in 1992 (André Sabourin, personal communication 1995). In our own experience, colonies observed in the late 1960s in The Burnt Lands Alvar (see *C. arietinum* account) and in various swamps continue to thrive.

EARLY HISTORY: The earliest known collections of *C. parviflorum* were the three made in 1861 and 1863 at Ramsay, Ontario, by John Kerr McMorine [QK 12719, 12726, 66622]. Another early collection was that of Braddish Billings (1867) in 1866; its current whereabouts is unknown. In 1870, Elizabeth Keen White painted a plant gathered from "low woods. Ottawa" by her husband, William White (Dore 1965*).

Collections in local herbaria show that in the early days *C. parviflorum* was found close to the city in a variety of rocky woods and swamps on both sides of the Ottawa River. James Fletcher (1893) described it as local but abundant. Fairy Lake and Beaver Meadow (Fletcher, Small, and Baptie 1887a) on the Quebec side, and Dow's Swamp, MacKay's Grove and Billings Bridge on the Ontario side were well-known localities. Lemieux Island and other rocky areas above and around Chaudière Falls supported a large population and some plants persisted on

Lemieux Island until at least 1925 [DAO 627979]. In 1897, Whyte, Craig and Macoun noted that many local populations were disappearing, the inevitable result of the growth of the city.

DERMATITIS: This species can produce dermatitis similar to that from *Cypripedium reginae*. (For a review, see Hausen (1984).) In our trials, all pubescent parts, flowers, leaves, stems and new shoots, caused irritation within a few days (Reddoch and Reddoch 1984).

Cypripedium reginae Walter

Showy Lady's-slipper

Cypripède royal

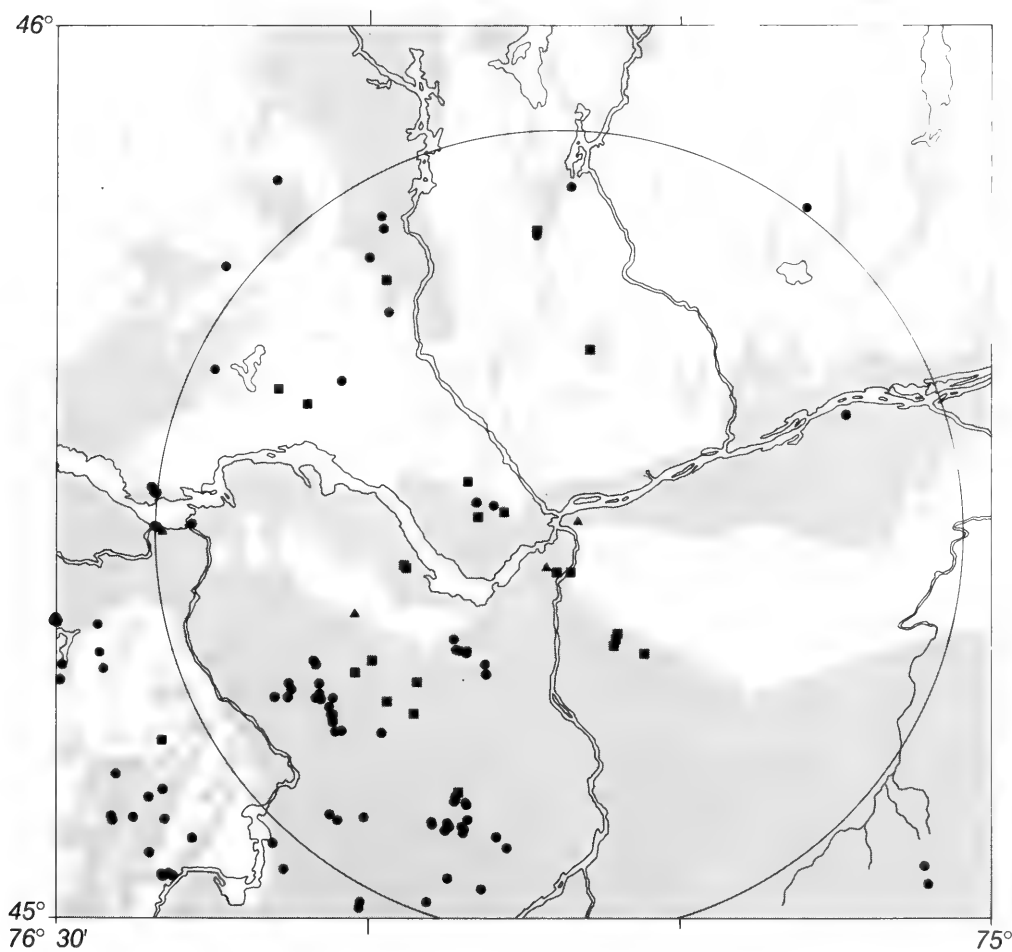
SYNONYMS: *Cypripedium spectabile* Salisbury, *C. hirsutum* Miller

Cypripedium reginae is indeed a showy plant with its large, bright flowers and its frequently large colonies. However, while its image is familiar, the living plant is perhaps less so because it tends to occur in relatively inaccessible wetlands. It is readily recognized by its magenta and white-lipped flowers and large, pubescent, cauline leaves.

DESCRIPTION

Height: 33 (40 - 62) 81 cm [40 plants].
Flowers: 1 - 2; large, lip white with greyish magenta or purplish red of variable intensity, occasionally very faint, on front, sides and top, often as diffuse vertical bands separated by white lines marking the veins, and rows of similarly coloured spots on interior; staminode white with broad yellow bands along edges toward apex, with spots or irregular lines, above and below, of orange brown or darker, depending on the anthocyanin concentration, superimposed on the yellow bands; sepals and petals

white, with some long pubescence at base of petals; fragrance delicate, sweet, floral, rose or raspberry-like.
Leaves: 4 - 7, large, pubescent, strongly ribbed, in a spiral around the stem; 4 - 7 on non-flowering plants.
Overwintering State: one or more greyish green shoots, 8 mm in diameter, about 6 cm down in the moss substrate beside the current year's stem, by early fall (see illustration of rhizome and buds in Whitlow (1983)).
Capsules: light brown, ellipsoid, typically 3.6 x



Cypripedium reginae: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record, ▲ = literature reference. Major areas underlain by calcareous rock (marble and limestone) are shaded.

1.2 cm, ascending and erect, often with remains of flower, persisting for one or sometimes two years; yield relatively low, averaging 25% [78 plants].

Seeds: greyish orange, released in mid to late September, some three weeks earlier than our other *Cypripediums*.

BLOOMING PERIOD: 27 May (14 June - 4 July) 14 July [64 records], the latest of our *Cypripediums*.

Colony Sizes: 1 - 1000, typically to 250, flowering and non-flowering plants [128 colonies]; occurring singly and in clumps.

CURRENT STATUS: rare in the Province of Quebec (Bouchard et al. 1983).

DISTRIBUTION: The Ottawa District lies near the northern boundary of the distribution of this essentially Great Lakes - St. Lawrence - Atlantic Coast orchid. It is a species of the Mixed Forest Region and adjacent regions. Within the District, colonies are scattered across those parts of the Lowlands and the Shield where limestone and marble bedrocks are close to the surface.

HABITATS: Calcareous fens and swamps are the most common habitats for *C. reginae*. In these wetlands, plants are scattered in and around openings and edges where there is no more than partial shade. Occasionally, a few plants live for a few years in mesic forests adjacent to the wetlands. *Cypripedium parviflorum* is a frequent companion in all habitats.

In fens, colonies grow in wet peat among Eastern White Cedar, Black Spruce and Tamarack with the usual fen mosses and vascular plants, most frequently with various sedges and Marsh Fern (*Thelypteris palustris*) and Labrador Tea (*Ledum groenlandicum*).

Swamps range in type from mostly coniferous: Eastern White Cedar, White Spruce, Balsam Fir and Tamarack, through various mixtures to mostly deciduous: Black Ash, White Elm and Red Maple. Characteristic ground cover sharing the wet humus or peat includes various calcareous swamp mosses, Rattlesnake Fern (*Botrychium virginianum*), Cinnamon Fern (*Osmunda cinnamomea*), Bulblet Fern (*Cystopteris bulbifera*), Crested Wood Fern (*Dryopteris cristata*), Oak Fern (*Gymnocarpium dryopteris*), Sensitive Fern (*Onoclea sensibilis*) and Poison Ivy (*Rhus radicans*).

Ditches along railway lines through calcareous swamps sometimes provide favourable environments for hundreds of *C. reginae* while the adjacent, more shaded swamps may contain only a few plants.

LONG-LIVED COLONIES: Under favourable conditions, colonies continue to bloom year after year, but they disappear quickly when they become too shaded or if the water regime changes.

Purdon's Fen, just outside the Study Area near McDonald's Corners, Ontario, is a well-known place to enjoy thousands of Showy Lady's-slippers every June. The wetland property was purchased by the Mississippi Valley Conservation Authority in 1984. Joe Purdon told us that in the 1930s he had noticed that many new orchids appeared in a part of the fen that had been logged a few years before, while they were disappearing from more shaded areas. After experimenting in a small area, he adopted the practice of selective thinning of the Eastern White Cedar trees and at the same time controlling beaver activities to maintain a constant water level. From a few dozen plants, the fen now shelters an estimated 16 000 (Mosquin 1986*; White 1988). This is the only place where we have seen a three-flowered plant.

The colony at Chilcott's Swamp described in 1893 by Whyte, Craig and Cowley (1893) was still extant in 1992 (André Sabourin, personal communication 1995). (See also below.)

EARLY HISTORY: The first Ottawa District collection was likely made in 1866 by Braddish Billings Jr. (1867). The whereabouts of this collection is unknown, but he could have made it in Dow's Swamp, less than 2 km west of the family home at Billings Bridge. A year later, John Kerr McMorine collected this orchid "near Clayton, Ramsay" in Lanark County at the western edge of the Study Area [DAO 25692]. There are several extant collections taken from Dow's Swamp between 1879 and 1909.

Chilcott's Swamp was discovered in late 1892 and the next year naturalists found it "to contain large numbers of the Showy Ladies-slipper (*Cypripedium spectabile*). The display of these lovely plants was even more extensive than had been expected, and charmed and delighted the party, who returned laden with spoil" (Whyte, Craig, and Cowley 1893). In 1912, Faith Fyles related that "Lady Grey paid a visit to the swamp when the Showy Lady's Slippers were in full bloom, and she sat [on a stump] to rest in the midst of thousands of these beautiful pink and white orchids". (Alice, Lady Grey, was the wife of Albert Edward, 4th Earl Grey, who was Canadian Governor General from 1904 to 1911 (Hubbard 1977) and patron of The Ottawa Field-Naturalists' Club.)

James Fletcher (1893) considered this orchid to be common. "This is probably our most beautiful wild flower, but [it] is gradually disappearing from ruthless digging up of the roots".

ABERRATION: The number of flowers examined is fairly small and only one aberration has been noted in our plants. This is a two-flowered plant recorded in photographs (at DAO) by Beatrice Treichler near White Lake in which one flower was normal while the other lacked a lip and had a row of magenta spots along the lower edge of one petal.



FIGURE 13. *Cypripedium reginae*, cedar swamp habitat, McNab Township, Renfrew County, Ontario, 12 June 1979.

DERMATITIS: Contact dermatitis caused by *C. reginae*, although perhaps not widely known, has been reported for over a century (see Reddoch and Reddoch 1984; Hausen 1984). Each of us has had quite marked reactions comparable to that from Poison Ivy within two days of contact, accidentally

as a result of measuring living plants and deliberately in tests to verify the source of the affliction. On the other hand, Joe Purdon (see above), who handled the plants on his property frequently over a period of at least 50 years, told us that he had never had any reaction to them.

Epipactis helleborine (Linnaeus) Crantz

Broad-leaved Helleborine

Epipactis petit-hellébore

Epipactis helleborine, an Old World species, was collected in Ottawa half a century after its discovery at Syracuse, New York, the earliest North American record. In the following 65 years, it has become the most common orchid in the District. As in much of its range, it shows great variation in stature and flower colour. It can be recognized by its several cauline leaves, the lowest of which is oval and much shorter than the one above it, by its stem that is sometimes greyish magenta toward the base and by its green and greyish magenta flowers with an open, cup-shaped hypochile (basal part of lip).

DESCRIPTION

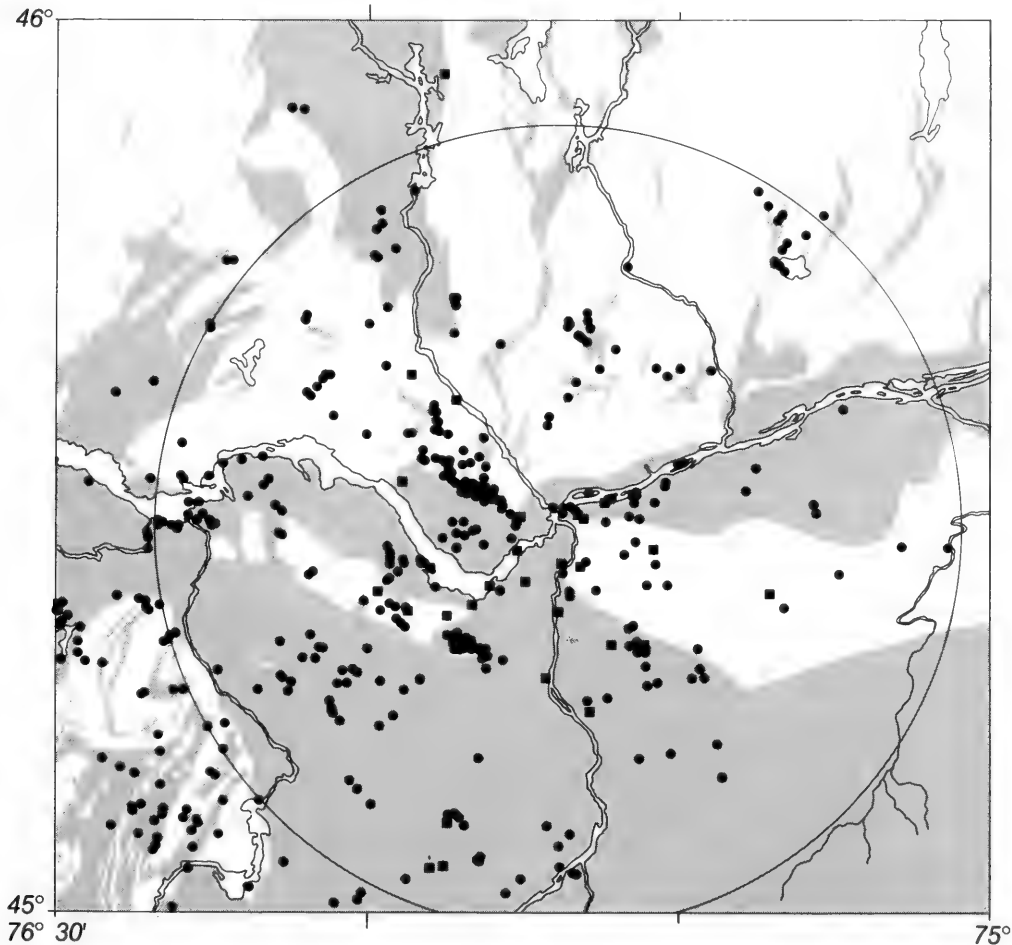
Height: 10 (28 - 60) 102 cm [232 plants]; the relative variation of the height (the ratio of the standard deviation of the height to the average height is 0.37) is exceeded only by that of *Platanthera hyperborea*, which has two habitat-dependent forms.

Flowers: 2 (6 - 32) 53 [103 plants]; colours showing considerable variation from plant to plant, reflecting differing amounts of chlorophyll and anthocyanin, the latter also increasing as flowers age; sepals greyish green or deep green sometimes with some red; petals often greyish magenta, but also pink, dark purple, etc. as well as white, violet white and pale green; epichile (apical part of lip) similar to

petals but usually somewhat lighter, e.g., white, pink, greyish ruby; interior of hypochile cup usually darker than petals, e.g., greyish magenta, dark ruby, reddish brown, violet brown, but occasionally very light, e.g., pale red (peach); often in a one-sided inflorescence as flowers turn toward the light; drooping with age; fragrance slightly sweet or lacking.

Leaves: 3 - 14 leaves and bracts, typically 3 - 8, 5 - 6 in 60% of plants [105 plants]; 2 - 5, rarely 1, on non-flowering plants (Marilyn Light, personal communication 1996).

Overwintering State: one to several white to pinkish buds, 5 to 16 cm or more below ground, rarely at ground level, beside the current year's stem;



Epipactis helleborine: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record. Major areas underlain by calcareous rock (marble and limestone) are shaded.



FIGURE 14. *Epipactis helleborine*, edge of mixed forest, Gatineau Park, Quebec, 9 August 1980.

Light and MacConaill (1991) observed at their study site in lower Gatineau Park that the perennating bud and flower primordia form one or more years before they emerge; the shoots of the year appear above ground in late May.

Capsules: brownish orange, ellipsoid to spheroid, typically 1.1 x 0.7 cm to 1.9 x 1 cm, descending; yield highly variable often approaching 100%, averaging 80% [63 plants].

Seeds: light yellow to greyish orange, released in late August to early October.

BLOOMING PERIOD: 18 June (15 July - 12 August) 29 August and 15 September [80 records].

COLONY SIZES: 1 - 1000, typically to 300, flowering plants [191 colonies], as scattered individuals and occasionally in clumps of up to a dozen stems.

CURRENT STATUS: the only orchid that can be considered common in the District, with many more locations than the distribution map shows; this species has become so abundant that people no longer record its presence.

DISTRIBUTION: The Ottawa District is in the northern part of the North American range of this introduced orchid. It is spreading slowly through the Mixed Forest Region and in other, scattered parts of the continent (Soper and Murray 1985; Homoya 1993). *Epipactis helleborine* is widespread and abundant throughout the District, especially in areas of calcareous bedrock.

HABITATS: This orchid is found most often in the moderate to deep shade of mesic, deciduous and mixed forests; however, it occurs in most types of forests from young to mature and from deciduous to coniferous. Occasionally, plants also grow in the wet-mesic soils of swamps and forested stream edges. These treed habitats are usually relatively open at ground level with little other vegetation near the plants except mosses.

More open environments for *E. helleborine* are forest edges and tracks, and, increasingly in recent years, old-fields, suburban lawns and gardens. (See Dore (1968, 1977, 1986) for garden occurrences and persistence.)

The plants are rooted in soils that range in composition from pure clays and sands to the corresponding loams; in swamps, the substrate is usually organic.

LOCAL HISTORY: *Epipactis helleborine* has been in the Ottawa District since at least 1930 when Hoyes Lloyd collected it on his property in Rockcliffe Park Village [TRT 202651] (Malte 1933). This 0.6 ha property at 285 Mariposa Avenue supported a mesic, mature Sugar Maple forest with a rich spring flora (Elizabeth Lloyd, personal communication 1981) until it was subdivided after Mr. Lloyd's death in 1978. Remnants remain to the present.

Herbarium collections and field observations suggest that *E. helleborine* did not begin to be common in the District until the 1960s (John Arnold, personal communication 1977; Dore 1968, 1977). The population seems to have established itself in two stages, the first being the appearance of a few individuals here and there on both the Lowlands and the Shield, and the second being the significant increase in the number of plants at sites already colonized, as well as the rapid emergence of new colonies. This latter process is continuing.

It is possible that the Ottawa population came up the Ottawa Valley from Montreal, 160 km to the east, where the species was first collected in 1892 and which is sometimes considered one point of introduction of the species in North America (Doyen and Cayouette 1966). However, it should be noted that Syracuse, New York, where the species was first discovered on this continent in 1879 (Correll 1950; Brackley 1985), is only 250 km to the south of Ottawa.

ACHLOROPHYLLOUS FORM: Two small plants of *E. helleborine* f. *monotropoides* (Mousley) Scoggan, were discovered by Bob Bracken in Stony Swamp in 1979 (A. H. Reddoch and J. M. Reddoch 1987b). The plants were about 15 cm tall and had 3 and 4 buds. We could see no evidence of chlorophyll in them; the leaves were pale grey. The lower parts of the stems were reddish lilac, showing the presence of anthocyanins that sometimes occurs in normal plant stems. The buds were light yellow. When the flowers opened, the lips were white except for the inner surface of the cup, which was light brown. These two plants withered during the flowering period and did not reappear the following year. They may have been under stress since they grew in quite thin soil over sandstone. Salmia (1986) reported that 70% of a colony of achlorophyllous plants in Finland appeared for only one year, while 27% appeared for two years and 4% for three years. This pattern is similar to that reported by Light and MacConaill for normal plants. (See Population Studies below.)

ABERRATION: One flower on an otherwise normal plant was partially doubled while retaining bilateral symmetry. It had four sepals, the extra one being opposite the dorsal sepal. It had two petals and a single broadened column, below which were two complete lips radiating away from the column.

INSECT PREDATION: We have seen a few examples of *E. helleborine* infested with weevils, identified by Anne Howden (personal communication 1995) as *Stethobaris ovata* (LeConte), an insect found on several local orchid species (Howden 1995). They were clustered in the inflorescence feeding on the rachis and inhibiting the development of the inflorescence.

POPULATION STUDIES: For more than a decade, Marilyn Light and Michael MacConaill (1990, 1991,

1994) have studied a large colony of *E. helleborine* in Gatineau Park and have reported on patterns of appearance and correlations with variations of climate (as well as below-ground changes; see Overwintering State above). Over a six year period, they found that only two plants appeared every year, while two-thirds appeared only once in that time. The rhizomes of half of the dormant plants remained alive and three plants reappeared after a three-year absence. They also determined that the appearance of plants is strongly correlated with the amount of rainfall in the previous August and September and that plants growing in the open are more likely to reappear than those in shaded areas.

MYCORRHIZA: In 1979, W. I. Illman collected a plant from beneath an old Red Oak on his lawn in

southeast Ottawa [DAO 124498]. He appended a discussion of a fungus surrounding the roots and of fungal hyphae that had invaded some cortical cells, implying a mycorrhizal association. The fungus had been identified by J. Bissett as *Trichoderma hamatum* (Bon) Bain. Because this common and readily apparent soil fungus is not known to form mycorrhizae, it seems likely that the hyphae in the root cells came from some other, less easily detected fungal species (Jim Ginns, personal communication 1996). W. G. Dore (1986) refers to the above collection and to a plant on his own lawn, noting that fine roots from nearby trees entered the mass of the soil fungus surrounding the *E. helleborine* roots but that they did not seem to have any physiological connection. Thus the nature of mycorrhizal activity in mature plants in the District remains unclear.

Galearis spectabilis (Linnaeus) Rafinesque

Showy Orchis

Galéaris remarquable

SYNONYM: *Orchis spectabilis* Linnaeus

Galearis spectabilis, as part of the spring woodland flora, is one of the earliest orchids to bloom in the District. It can occur in sizable patches and, although not particularly showy from a distance, has attractive flowers. It can be recognized by the two oval basal leaves and the inflorescence of several lilac-coloured flowers with usually whitish lips.

DESCRIPTION

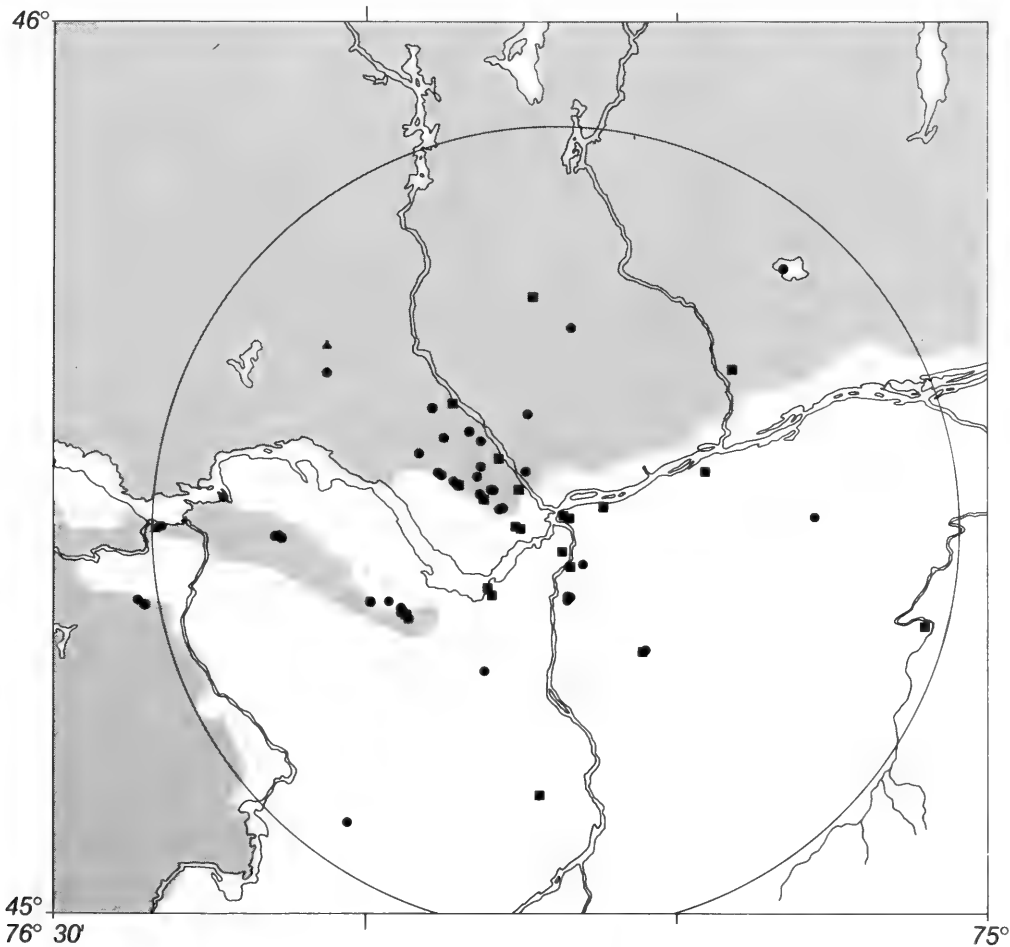
Height: 5 (9 - 15) 21 cm [269 plants]; appreciably shorter than the 35 cm reported (Correll 1950, Luer 1975) for plants presumably from the southern part of the range, but quite comparable to heights from the northern part (Case 1987; Smith 1993).

Flowers: 1 (2 - 5) 7 [303 plants], about half as many as reported on southern plants (Luer 1975); sepals and petals typically light lilac, ranging from violet white and pale violet to lilac; lip white, yellowish white or yellowish grey or like sepals (see Colour Pattern Variant below); column darker and sometimes redder than sepals, thus purple, greyish magenta or greyish rose; spur usually translucent

white but occasionally with traces of lilac; lateral sepals connivent with petals and dorsal sepal to form a galea, but rarely free and spreading; flowers in a somewhat one-sided and irregular inflorescence; fragrance moderate, floral or sometimes undetectable.

Leaves: 2, basal, with occasionally one large cauline bract on flowering plants; 1 or, more commonly, 2 leaves on non-flowering plants.

Overwintering State: one or more greyish green, broadly conical shoots, about 1 cm above ground, appearing beside the current year's stem in late September; herbarium specimens show the new shoot bud and partially elongated roots already present at anthesis.



Galearis spectabilis: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record, ▲ = literature reference. The Canadian Shield is shaded.

Capsules: light brown, ellipsoid, typically 1.9 x 0.5 cm, erect or nearly so; yield usually less than 60%, averaging 45% [32 plants], appreciably higher than the 5% yield reported for Ohio (Deringer 1982).

Seeds: dark brown, released in early October.

BLOOMING PERIOD: 15 May (23 May - 6 June) 15 June [72 records].

COLONY SIZES: 1 - 278, typically to 100, flowering and non-flowering plants [55 colonies], generally as small to large patches; non-flowering plants somewhat more abundant than flowering plants.

CURRENT STATUS: rare in the Province of Quebec (Bouchard et al. 1983).

DISTRIBUTION: The Ottawa District is close to the northern limit of distribution of this eastern orchid. It is a species of the Deciduous Forest Region and adjacent Mixed Forest Region.

Within the District, it occurs in scattered locations up to the southern part of the Canadian Shield north of the Ottawa River. In addition to the colonies mapped, Bob Bracken (personal communication 1989) encountered additional colonies in a number of farm woodlots on the Lowlands during a bird population survey.

HABITATS: This orchid is a plant of relatively open, deciduous or sometimes mixed forests that are semi-mature or mature. Sugar Maple is almost always the dominant tree, accompanied by a variety of other species. Ground cover is usually sparse but may include other spring wildflowers such as White Trillium (*Trillium grandiflorum*), as well as Maidenhair Fern (*Adiantum pedatum*), Christmas Fern (*Polystichum acrostichoides*), Wild Onion (*Allium canadense*) and Sugar Maple shoots. In the forest, the orchids grow in mesic or wet-mesic sandy loam or clay loam on the level floor or in depressions, seasonal runoff areas and at the bases of slopes. This species occurs over various bedrock types.

At two localities, we have seen a few plants in more open, drier situations beyond woodland edges, close to and under clumps of Eastern White Cedar at one site and of Juniper (*Juniperus communis*) at the other.

LONG-LIVED COLONIES: Colonies of *G. spectabilis* can persist and multiply for many decades if the site does not become heavily shaded or overgrown with vegetation such as maple shoots.

We have followed a colony in lower Gatineau Park from which W. G. Dore made a collection in 1969 [DAO 267276]. The number of plants has increased from 65 in 1973 to 173 by 1994. In 1973, 40% of the plants flowered, while in 1994, 46% flowered. About one-third of the plants produce flowers with coloured lips. (See Colour Pattern Variant below.)

The colony is situated in wet-mesic clay loam at the base of a steep, rocky, southwest-facing slope under a high, almost closed canopy. Sugar Maple is the dominant tree, accompanied by single trees of Yellow Birch, White Birch, Basswood, White Ash and Red Oak, and single saplings of Eastern Hemlock, Balsam Fir and Beech. The sparse herbaceous layer consists of a few plants of White Trillium and Early Meadow-rue (*Thalictrum dioicum*), as well as many Sugar Maple seedlings. The bedrock, much in evidence on the slope above, is marble.

Galearis spectabilis persisted in at least two suburban woodlots until two decades ago. We last saw a few plants in Pleasant Park Woods in Alta Vista (Reddoch 1972) in 1971 and 18 plants in Niven's Woods in Rothwell Heights (Reddoch 1980, [DAO 691465]) in 1980. The former colony probably died out naturally with increased shade, but the latter, while decreasing, was destroyed by housing development. It had been followed by Anne Hanes since the early 1960s. Both these woodlots were seven hectares in area.

EARLY HISTORY: *Galearis spectabilis* is one of the seven orchids that Braddish Billings Jr. (1867) included in his list of species collected in the summer of 1866, presumably in the vicinity of his family home at Billings Bridge. In 1869, Elizabeth Keen White painted a plant provided by her husband, William White, from "Rich woods. Ottawa" (Dore 1965*).

Macoun (*circa* 1911*) cited an 1878 collection by R. B. Whyte from "woods east of Bank St. road near Ottawa". James Fletcher collected *G. spectabilis* in 1878 and 1879 at Beaver Meadow, Hull [DAO 267272], the Chelsea Mountains (now Gatineau Park) [DAO 267273] and Patterson Creek Wood (in the Glebe in Ottawa) [DAO 17040]. In 1879, Henry M. Ami collected this orchid at MacKay's Grove [CAN 232401].

Galearis spectabilis was specifically mentioned in accounts of Ottawa Field-Naturalists' Club excursions to New Edinburgh and Hemlock (McKay) Lake (Fletcher, Small, and Baptie 1887b; Fletcher 1898), Beaver Meadow, Hull (Cowley, Macoun, and Whyte 1892; Eifrig 1909), Ironsides, Quebec (Halkett 1909) and Gilmour's Grove (Clarke 1904, 1908). Eifrig (1909) remarked that the west bank of Beaver Meadow was "perhaps the most prolific place near Ottawa for the botanist, rare plants like the showy orchis (*Orchis spectabilis*) being found there, as well as other kinds of commoner ones in profusion...". By 1913, Beaver Meadow was being destroyed by residential development (Anonymous 1913).

For his Beaver Meadow and Patterson Creek Wood collections, James Fletcher noted that the flowers were entirely the same colour, light mauve at the first site and deep purple at the second. Similarly,



FIGURE 15. *Galearis spectabilis*, mixed forest habitat, Gatineau Park, Quebec, 10 June 1970 (plant) and 25 May 1979 (column); for the column (front view), scale bar = 0.5 mm.

Clarke (1904) described the plants found on an excursion at Gilmour's Grove as having completely purple flowers. (See Colour Pattern Variant below.)

The photograph of this species that Charles Macnamara took in the Arnprior area on 7 June 1913 is shown in his undated manuscript (*circa* 1940*) and in Reddoch (1981c). This photograph, credited only to the American Orchid Society, is included in the book, *A History of the Orchid* (Reinikka 1972). *Galearis spectabilis* is considered to be rare in the Arnprior area (Runtz 1984).

COLOUR PATTERN VARIANT: *Galearis spectabilis* f. *willeyi* (Seymour) P. M. Brown has been seen in a number of colonies in both the Ontario and Quebec parts of the District (A. H. Reddoch and J. M. Reddoch 1987b). Some colonies are more prone

than others to produce plants with coloured lips. Although Seymour (1970) reported that Willey had observed the colours to be constant for several years, Marilyn Light (personal communication 1996) has determined that the effect is not reproducible from year to year. The lip colour of this putative form is similar to that of the sepals but can be variable in intensity and irregular in distribution. It is often lilac but can be a darker shade, such as purple, greyish violet or deep violet, or a fairly light one, such as light lilac or pale violet. The colour may be uniform across the lip or, when very light, merely a fringe near the edge of the lip. This form may be an example of the colour pattern variation arising from genetic mutation (Fincham 1987; Jorgensen 1995) or it may arise from environmental factors.

Goodyera pubescens (Willdenow) R. Brown in Aiton

Downy Rattlesnake-plantain

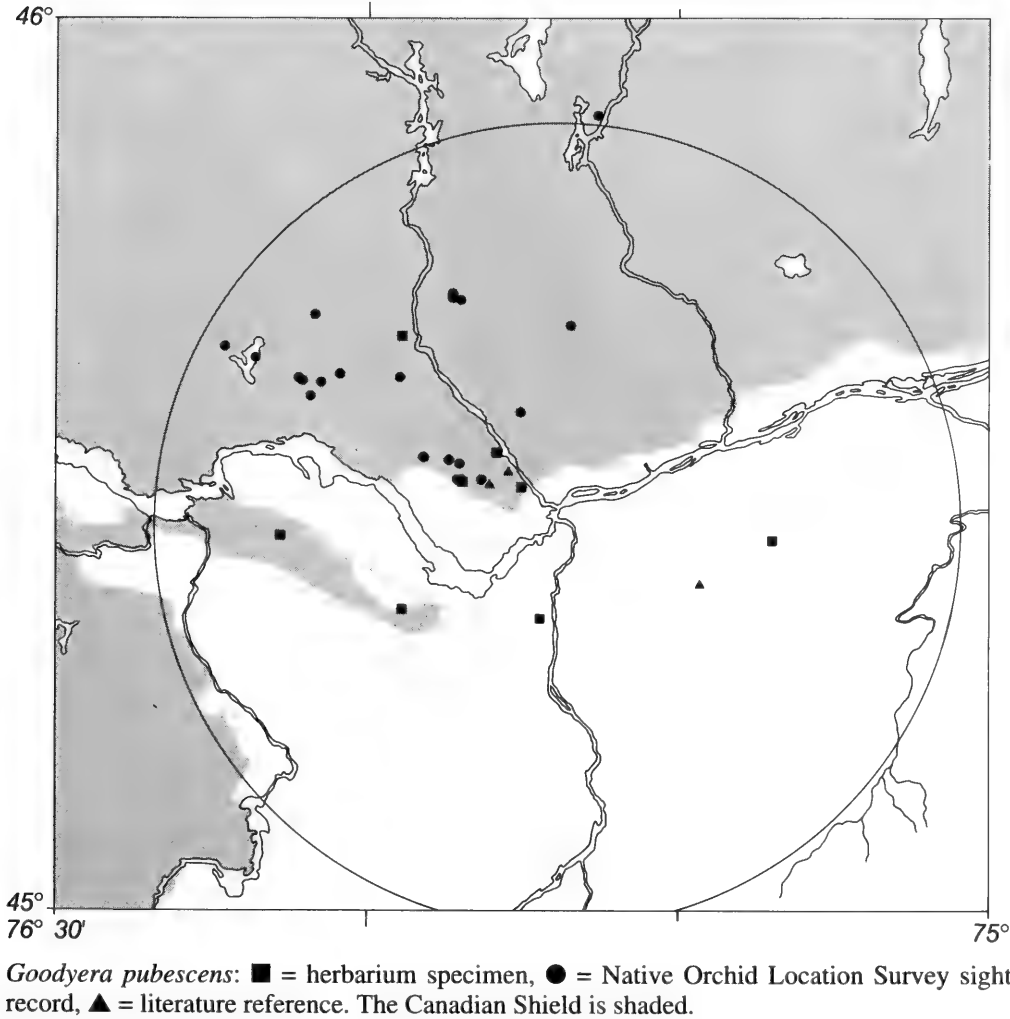
Goody rie pubescente

Goodyera pubescens is the largest of the three *Goodyeras* in the District. It is a species of mature, mesic forests and swamps that can form large patches by vegetative reproduction. These patches can be one or two metres across and can contain 100 to 200 plants. It can be recognized by its basal rosette of tessellated leaves with broad light green to nearly white lines bordering the median vein. It can be distinguished from *G. repens* by its cylindrical inflorescence. The most definitive character in separating *G. repens* and *G. tessellata*, the rostellar beak on the column, is essentially absent in this species (Whiting and Catling 1986).

DESCRIPTION

- Height:** 14 (19 - 27) 36 cm [164 plants].
- Flowers:** 7 (15 - 36) 64 [104 plants]; white, frequently with light green along veins of sepals and sometimes on tip of dorsal sepal; fragrance faintly sweet or spicy.
- Leaves:** 2 - 15, typically 2 - 11 [99 plants]; 2 - 4.5 cm long, 1.2 - 2.2 cm wide [98 leaves]; greyish green or dark green with light green to nearly white markings on upper surface only (see Figure).
- Overwintering State:** as a rosette of leaves (see Vegetative Reproduction and Flowering Frequency below).
- Capsules:** light brown, spheroid, typically 0.6 x

- 0.4 cm, ascending; yield often either 0% or approaching 100%, averaging 45% [57 plants].
- Seeds:** dark brown, released in mid October.
- BLOOMING PERIOD:** 26 July (4 August - 1 September) 20 September and 20 October [20 records].
- COLONY SIZES:** 2 - 321, typically to 250, flowering and non-flowering rosettes [21 colonies], as small groups or as patches of up to 200 rosettes.
- CURRENT STATUS:** rare in the Province of Quebec (Bouchard et al. 1983).
- DISTRIBUTION:** The Ottawa District is close to the



northern edge of the distribution of this eastern species of the Mixed and Deciduous Forest Regions. Within the District, this orchid is thinly scattered across the Shield over a variety of bedrock types. It is represented on the Lowlands only by collections from 1903 and 1945.

HABITATS: *Goodyera pubescens* is a plant of fairly mature mesic forests and sometimes of swamps. In all habitats, it inhabits areas of dappled to deep shade with little other ground cover except mosses.

This orchid is most often found in deciduous or mixed forests and only occasionally in dominantly coniferous forests. It thrives in forests of Sugar Maple with Beech or with conifers such as Eastern White Pine, Eastern Hemlock, Balsam Fir and Eastern White Cedar. (See Long-lived Colonies below for additional details.) The plants are as likely to be on a flat forest floor as on a slope beside a stream or pond. There is typically little other vegetation sharing the usually deep, but sometimes shallow, sandy or sandy loam substrate. Some companion species are Bristly Clubmoss (*Lycopodium annotinum*), Bluebead-lily (*Clintonia borealis*), Wild Lily-of-the-valley (*Maianthemum canadense*), Goldthread (*Coptis trifolia*) and Wild Sarsaparilla (*Aralia nudicaulis*).

In the typical Ottawa District cedar swamps, rosettes of *G. pubescens* occasionally line mossy, rotting logs or grow on peaty mounds close to trees. Eastern White Cedar is accompanied by such trees as Black Ash, Yellow Birch, White Elm, Balsam Fir, Red Maple and Largetooth Aspen.

LONG-LIVED COLONIES: Since 1975, we have followed a flourishing colony of *G. pubescens* in lower Gatineau Park. (There is a herbarium specimen taken by D. Erskine from this locality in 1968 [DAO 96646].) There are eight separate groups of plants scattered over a distance of 200 metres and ranging in size from a dense patch of 200 rosettes to a small group of eight. The large groups were well-established in 1975 while the smallest one is fairly recent. The orchids grow in shallow or deep sand, on slopes or on flat land, over bedrock of marble, calc gneiss and granite pegmatite (Hogarth 1970). The largest patches are in a dominantly Eastern Hemlock stand with Red Oak and Beech, while other groups are under Sugar Maple with White Pine, Eastern Hemlock and Hop Hornbeam. Most plants are in dappled shade, but it is clear at one location that those plants in a small opening, and thus receiving more light, are larger. However, another group in a somewhat sunny location disappeared during the course of our study. Burial of the plants by heavy layers of fallen leaves compacted by winter snow and deer browsing of the inflorescences are hazards in this location.

Five km to the northwest, there is another colony of *G. pubescens* that we have followed and pho-

tographed from time to time since 1975. (The plant illustrated in the Figure grew in this colony.) It is on a north-facing slope of a small stream valley under a canopy of Beech and Sugar Maple. The bedrock below the sandy substrate is porphyroidal gneiss (Hogarth 1970). The 15 rosettes present in 1975 had multiplied to 66 in 1987 and currently (1996) number 86. The 65 cm x 40 cm area of the colony in 1975 has expanded to 135 cm x 100 cm in 1996.

Because the pattern on each leaf is different, we have been able to trace the season by season development of some of the rosettes in these colonies. Our findings are reported under Vegetative Reproduction and Flowering Frequency below.

EARLY HISTORY: Most early collections of *G. pubescens* came from the lower Gatineau valley. William Scott discovered the first colony in the District in 1891 near Ironsides, Quebec (Fletcher, Scott, and Cowley 1892). He collected several specimens there in July and, with John Macoun, in September of that year [DAO 96648, TRT 15483; TRT 15481, 15488, CAN 116928]. Macoun (*circa* 1911*) described the locality as "in the pine woods towards Chelsea beyond Ironsides". He listed two other collections of his, one "by the mountain on the old mine road to Old Chelsea" in 1902 (current whereabouts unknown) and "in woods near Wakefield" in 1903 [TRT 15502]. Botanists found additional colonies in the lower Gatineau valley near Chelsea in 1906 and near Ironsides in 1918 (specimens at CAN). James Fletcher (1893) also included Hull and Kingsmere as localities for this species.

John Macoun collected both *G. pubescens* and *G. tessellata* at Leonard, Ontario, in 1903 (specimens at CAN). In his *circa* 1911* list of the Ottawa flora, Macoun stated that he made these collections, as well as one of *G. pubescens* in 1911 (current whereabouts unknown), "in thick woods at Leonard station, C.P.R. Short Line". He also cited an R. B. Whyte collection of unknown date from "Eastman Springs" (= Carlsbad Springs, Ontario).

Charles Macnamara (*circa* 1940*) included *G. pubescens* in his treatment of the orchids of the Arnprior area; however, the photograph that he used to illustrate this species shows clearly that the plants he described were *G. tessellata*. *Goodyera pubescens* has not been found in the Arnprior area in more recent years either (Runtz 1984, personal communication 1995).

VEGETATIVE REPRODUCTION AND FLOWERING FREQUENCY: A plant, as the term is used in this section, consists of a rhizome that is or has been sheathed with leaves along its length and that terminates in a rosette of leaves and a growing tip. (The rhizome originated from a parent rhizome the year after the parent plant flowered.) As the rhizome grows, it puts down a few roots and the old leaves



FIGURE 16. *Goodyera pubescens*, deciduous forest habitat, Gatineau Park, Quebec, 25 August 1979.

die in turn, leaving rings around the rhizome to mark where they were attached. These rings or leaf scars are from 0.5 cm to 2.2 cm apart. The rhizome is usually on or just below the surface of the humus or soil substrate; it may be straight or with bends where the growing tip changed direction. When a plant flowers, the inflorescence rises from the centre of the rosette, first appearing in early June.

The year after a plant flowers, one to three, rarely four, new growths emerge from the rhizome among the older leaves of the plant and extend distances of three to five cm from the parent. The parent plant dies that year or the next. The weakest of the growths often dies within a year. Each new growth produces two leaves the first year; the maturing plant generates three to five new leaves each year until the year it flowers. (It does not produce any leaves the year it flowers other than sometimes one or a few narrow, basal-cauline leaves.) Each leaf lasts two to four years, the lifetime being shorter for leaves heavily covered with fallen tree leaves. (Keenan (1990) reported a lifetime of four years in New Hampshire.) By the time a plant flowers, after a minimum of three years and typically five to eight years, it has generated a total of 21 - 30 leaves, 8 - 15 of which are still present at flowering. The growing tip is now 14 - 18 cm from the parent. The progeny of the same parent do not all bloom the same year; the most robust plant (generated more leaves, travelled farther) flowers first and some plants do not flower at

all. The qualitative features described here are similar to those reported by Ackerman (1975) for *Goodyera oblongifolia* in California.

Usually only a few of the plants in a colony bloom each year; the yearly average over 20 years for the colonies described above under Long-lived Colonies was 11%. However, the percentage of plants flowering from year to year is not at all uniform; in some years as many as 66% of the plants produce flowers, while in other years none do. We have found that there is a tendency for the colonies described above to behave similarly, having simultaneous large, modest or zero flowerings. There were large flowerings in 1982, 1986, 1989, 1994 and 1996, and slight or zero flowerings in 1977, 1983, 1985, 1987, 1990, 1991, 1993, and 1995.

Of the four groups in the first colony described above for which we have extensive records, three showed intergroup correlations of annual flower production that are statistically significant at the 1% level or better. The fourth group, followed for 11 years, did not show high correlations with the others. (Its growth cycle was frequently interrupted by burial in fallen leaves borne by drainage on a steep slope.) These groups also correlated with the colony 5 km away with a significance level of 5% or better. Such correlated, but irregular, flowering suggests the influence of external factors, presumably the annual weather patterns, perhaps with some local variation in sensitivity to these factors.

Goodyera repens (Linnaeus) R. Brown in Aiton var. *ophioides* Fernald

Lesser Rattlesnake-plantain

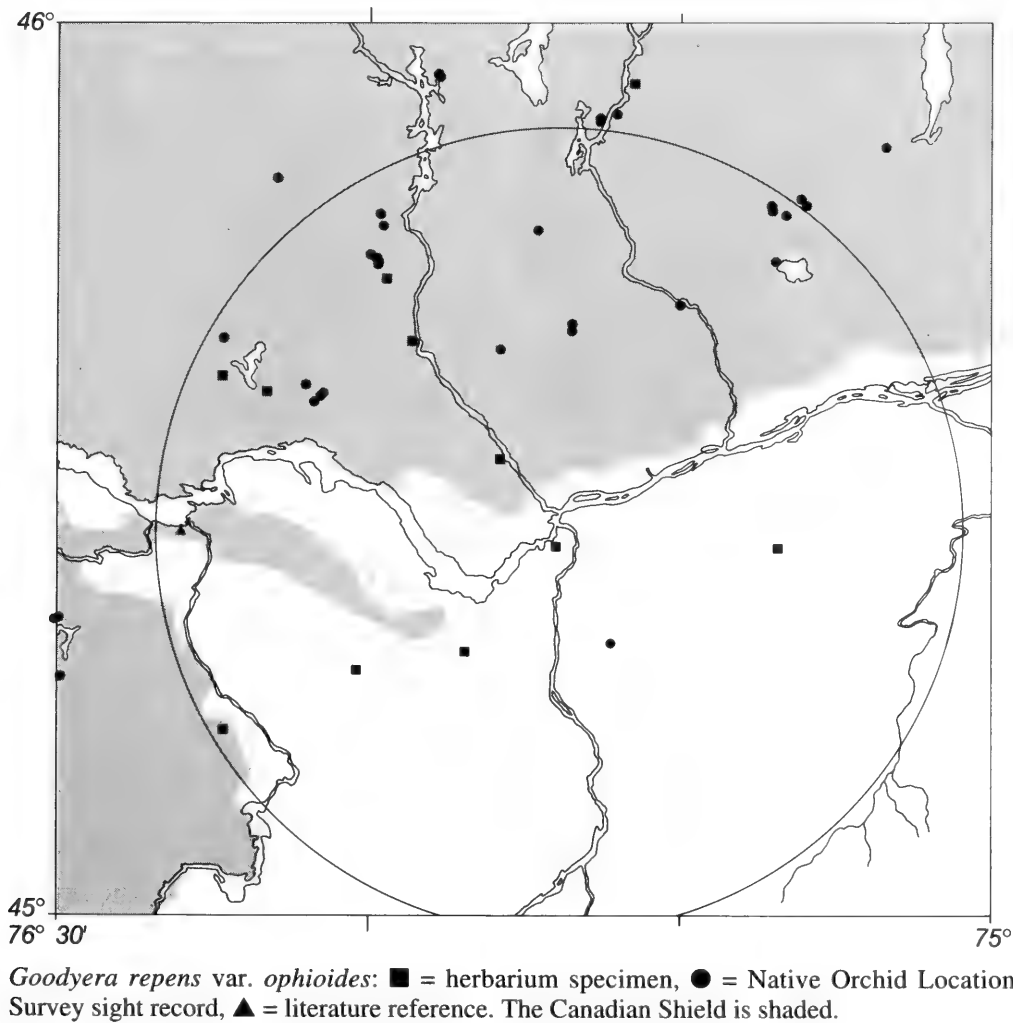
Goody rie rampante

Goodyera repens is the smallest of the three *Goodyeras* in the District. It is a species of dense, shady forests and swamps that can form small, compact patches by vegetative reproduction. It can be recognized by its basal rosette of tessellated leaves lacking light lines along the median vein and can be distinguished from *G. pubescens* by its essentially one-sided inflorescence. The most definitive, but not most convenient, character is the rostellar beak length, which is less than 0.5 mm (Kallunki 1976).

DESCRIPTION

- Height:** 4 (7 - 14) 19 cm [67 plants].
- Flowers:** 1 (7 - 16) 28 [62 plants]; white, sometimes with a slight greenish tinge on the veins on the outside of the sepals of the upper flowers; tending to face the brightest available light in a one-sided inflorescence.
- Leaves:** 2 - 7 [28 plants]; 1.4 - 2.8 cm long, 0.8 - 1.5 cm wide [17 leaves]; greyish green or dark green with light green markings bordering the veins except the median vein (see Figure); occasionally the lowest cauline bract enlarged and leaf-like.
- Overwintering State:** as a rosette of leaves (vegetative reproduction apparently similar qualitatively to *G. tessellata*).
- Capsules:** light brown, spheroid, typically 0.5 x

- 0.3 cm, ascending (see Figure 1a); yield highly variable but usually low, averaging 30% [44 plants].
- Seeds:** released in early October.
- BLOOMING PERIOD:** 7 July (20 July - 15 August) 27 August [19 records].
- COLONY SIZES:** 1 - 208, typically to 70, flowering and non-flowering rosettes [37 colonies], as scattered individuals and small groups, occasionally in patches of as many as 90 rosettes (see Long-lived Colonies below).
- DISTRIBUTION:** The Ottawa District is well within the range of this mainly eastern variety of *G. repens* (Kallunki 1976). It occupies primarily the Mixed Forest Region and adjacent Boreal Forest Region. Within the District, this orchid is thinly scattered



across the Shield and rarely present on the Lowlands.

HABITATS: *Goodyera repens* is a plant of dense, shady, coniferous forests and swamps. It also occurs occasionally in mixed forests and on forested slopes adjacent to wetter areas.

The mesic coniferous forests that harbour *G. repens* are composed of trees such as Eastern Hemlock, Balsam Fir, Eastern White Cedar and White Spruce. The plants grow among mosses or in leaf mould on the otherwise relatively bare forest floor. Sometimes they are accompanied by such herbs as Goldthread (*Coptis trifolia*), Wild Sarsaparilla (*Aralia nudicaulis*) and Bunchberry (*Cornus canadensis*). Occasionally, *Goodyera tessellata* is also present.

The coniferous swamps are generally in areas of calcareous bedrock. They are usually dominated by fairly mature Eastern White Cedar, accompanied by a selection of other trees such as Black Spruce, White Spruce, Tamarack and Black Ash. The trees are often well-spaced with little under-story. *Goodyera repens* plants are rooted in the moist to saturated humus of the swamp floor and on mounds around trees, among leaf litter or mosses. Accompanying herbs may include *Corallorhiza trifida*, *Cypripedium acaule*, *Malaxis monophylla*, *Platanthera hyperborea*, *P. obtusata*, *P. orbiculata*, Foamflower (*Tiarella cordifolia*), Wild Sarsaparilla and One-flowered Wintergreen (*Moneses uniflora*).

LONG-LIVED COLONIES: In 1977, Clarence and Enid Frankton showed us a colony of *G. repens* that they had discovered in 1972 in the Stony Swamp Conservation Area [DAO 627112]. There were about 90 rosettes, 80 of them in a dense patch 30 cm square and the rest less than a metre away. They were under a White Spruce in an Eastern White Cedar - White Spruce forest growing in a thin layer of leaf litter over Nepean sandstone. We measured a pH of 4.0 at the colony. Although the colony likely

had been there for a long time, it disappeared in the 1980s. Perhaps its location so closely in contact with the bedrock far from soil humidity made it particularly vulnerable to environmental stresses.

Near Poltimore, Quebec, a north-facing sandy slope above a fen supported several dozen scattered plants of *G. tessellata* and of *G. repens* in 1978. Logging removed much of the dominantly Balsam Fir forest cover in the early 1980s. By the mid-1990s, the decade-old growth of Trembling Aspen, Balsam Fir and Eastern Hemlock sheltered a similar mixed colony of these two orchids.

EARLY HISTORY: John Kerr McMorine collected *G. repens* in August 1862 at Ramsay, Ontario [DAO 96772, QK 12922]. James Fletcher made the only other known 19th century collection at "Stewart's Bush, Ottawa, Carleton Co." in 1879 [DAO 17595]. Elizabeth Keen White painted a plant provided by James Fletcher from "Rich Woods, Ottawa" in 1877 (Dore 1965*), possibly also Stewart's Bush.

John Macoun (*circa* 1911*) included in his list for *G. repens* three collections of his own, one currently at CAN that is referable to *G. repens* as well as two that we have not seen. He also included James Fletcher's specimen of *G. tessellata* that is currently at DAO (see *G. tessellata*). Given this mixed message as to Macoun's knowledge of *G. repens*, we have not mapped the two collections that we have not seen. It is interesting that the three Macoun specimens were collected near railway stations, the *G. repens* at CAN [116935] at "Wakefield, Quebec, in woods north of railway station, August 10, 1903", while the latter two unknown *Goodyeras* were collected "in the Mer Bleue at Blackburn Station, May 27, 1903" and "at Navan station, C.P.R. Short Line, September 5, 1911".

HYBRIDS: Kallunki (1976) has annotated two possible hybrids between *G. repens* and *G. tessellata*. Both are from Quebec, one from Gatineau Park [DAO 96754] and one from Papineau County [DAO 16902]. Such plants are extremely difficult to identify.

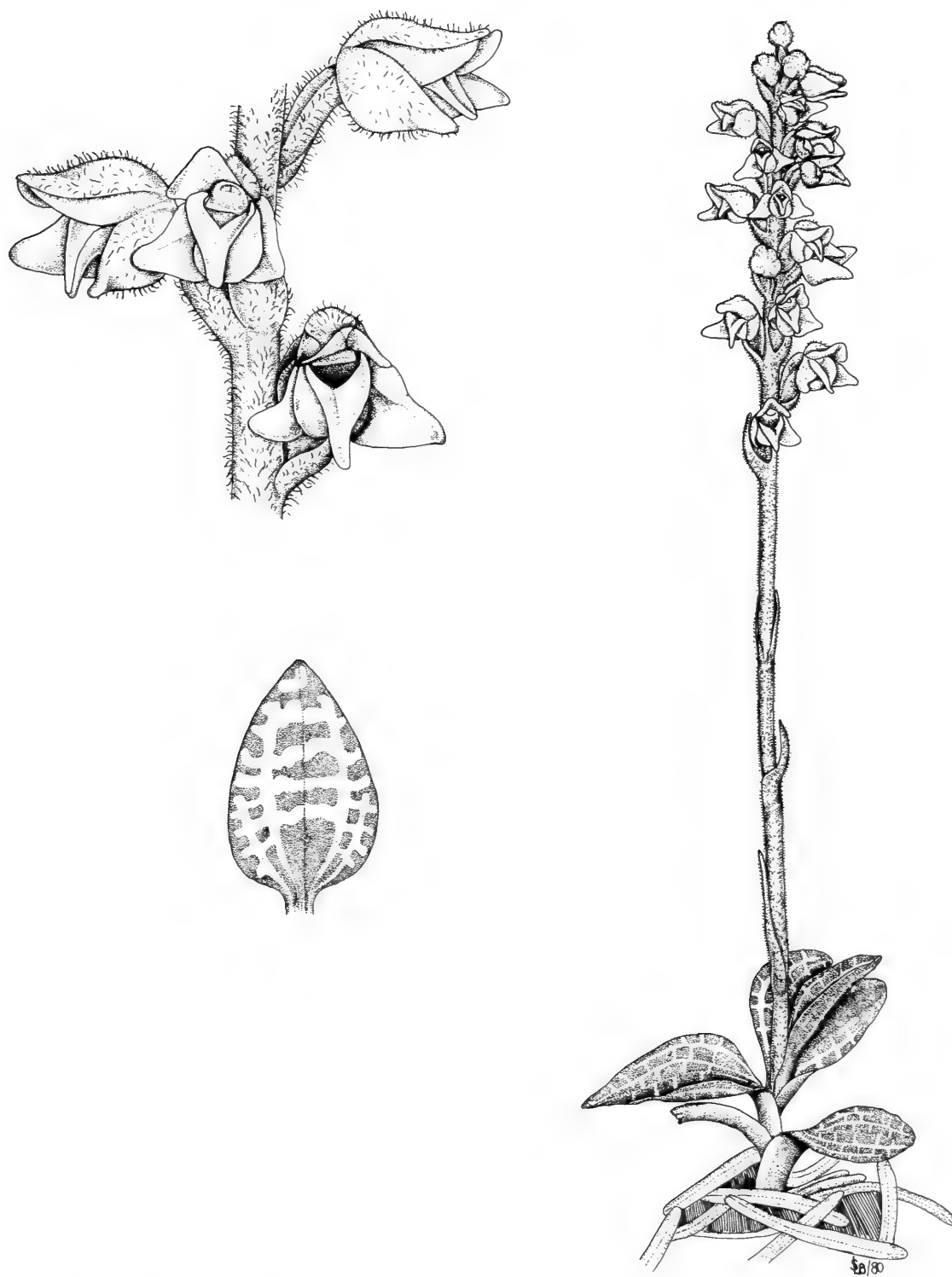


FIGURE 17. *Goodyera repens* var. *ophioides*, coniferous forest habitat, Val-des-Monts Municipality (Wakefield Township, Gatineau County), Quebec, 6 August 1978.

Goodyera tessellata Loddiges

Tessellated Rattlesnake-plantain

Goodyérie panachée

Goodyera tessellata is a species of shaded forests and swamps, particularly on the Shield, that can form small, dense patches by vegetative reproduction. It can be recognized by its basal rosette of tessellated leaves with narrow greenish white lines bordering the median vein. The most definitive, but not most convenient, character is the rostellar beak length, which lies between 0.5 mm and 2 mm (Kallunki 1976).

DESCRIPTION

Height: 12 (16 - 26) 31 cm [114 plants].

Flowers: 8 (16 - 29) 35 [65 plants]; white, tending to face the brightest available light in a somewhat one-sided inflorescence; fragrance faintly spicy.

Leaves: 2 - 5 on flowering and non-flowering plants, occasionally to 10 and rarely to 15 on non-flowering plants [48 plants]; 1.8 - 4 cm long, 0.9 - 1.8 cm wide [18 leaves]; greyish green (not bluish green as is sometimes reported), with greenish white markings on upper surface only (see Figure), markings occasionally broadened to cover most of leaf except directly over veins; occasionally 2 erect leaves at base of stem, occasionally lowest cauline bract expanded to form a small spatulate leaf.

Overwintering State: as a rosette of leaves (see

Vegetative Reproduction and Flowering Frequency below).

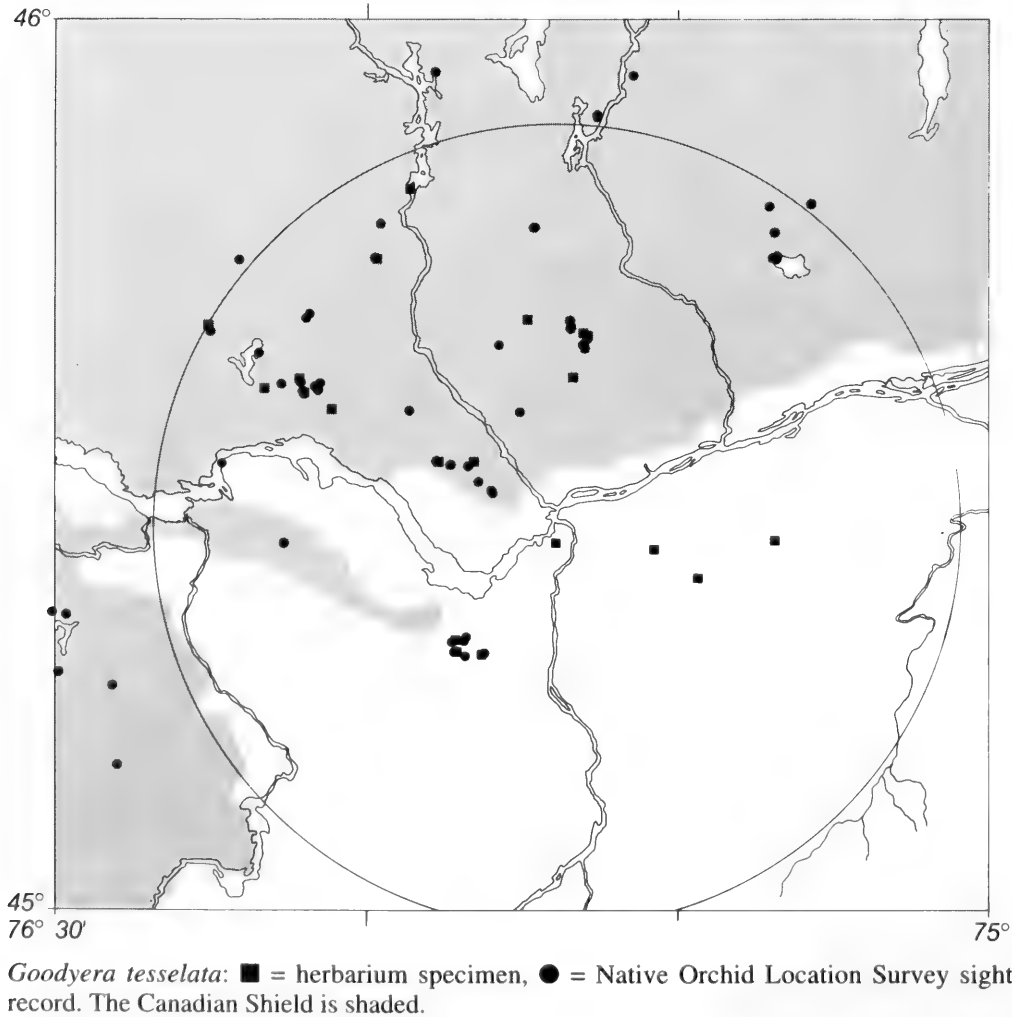
Capsules: light brown, spheroid, typically 0.4 x 0.35 cm, ascending (see Figure 1a); yield highly variable but usually high, averaging 70% [14 plants].

Seeds: brownish orange, released in early September, a month earlier than our other *Goodyeras*.

BLOOMING PERIOD: 9 July (20 July - 15 August) 3 September [36 records].

COLONY SIZES: 1 - 400, typically to 100, flowering and non-flowering rosettes [57 colonies], as scattered individuals, small clumps and patches of several dozen rosettes.

DISTRIBUTION: The Ottawa District is well within



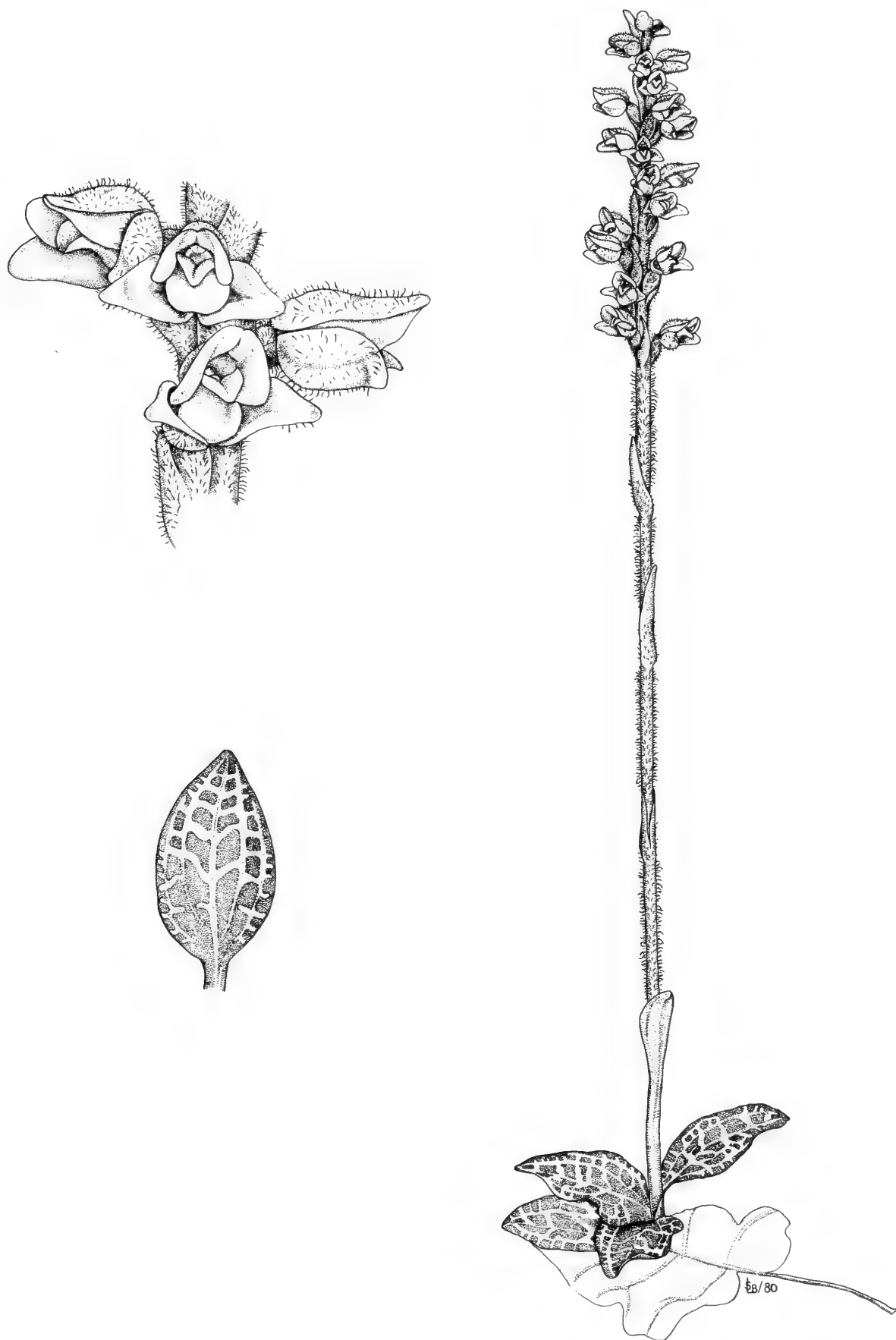


FIGURE 18. *Goodyera tessellata*, hemlock - maple - birch forest habitat, Gatineau Park, Quebec, 26 July 1975.

the range of this eastern orchid. It occurs predominantly in the Mixed Forest Region and adjacent Boreal Forest Region (Kallunki 1976). Within the District, *G. tessellata* is confined largely to the Canadian Shield, especially in areas of calcareous bedrock and of sand. On the Lowlands, the mixed sandstone and calcareous rocks of the Stony Swamp Conservation Area support an exceptionally large concentration of colonies.

HABITATS: Mature, mesic forests and various swamps are the two typical habitats for *G. tessellata* in the District. Forested slopes adjacent to swamps appear to be especially favoured localities. These habitats provide heavy shade, adequate moisture and little competition from other herbaceous plants.

Deciduous, mixed and coniferous forests important to this orchid are composed of various combinations of the following species (in order of decreasing frequency): Sugar Maple, Eastern Hemlock, Eastern White Pine, Eastern White Cedar, Yellow Birch, Balsam Fir, Beech and Largetooth Aspen. The leaf-covered sandy humus of the forest floor is sometimes shared, at a distance, with such species as Ground-cedar (*Lycopodium complanatum*), Shining Clubmoss (*L. lucidulum*), Wild Lily-of-the-valley (*Maianthemum canadense*) and Wild Sarsaparilla (*Aralia nudicaulis*). Occasionally, *Goodyera repens* and, rarely, *Corallorhiza striata*, *C. trifida*, *Cypripedium parviflorum* var. *pubescens*, *Epipactis helleborine* and *Platanthera hookeri* also occur. Rarely, *G. tessellata* is found at the interfaces between pine plantations and mixed forests. We have recorded a pH of 5.0 at two forest locations.

In swamps of Eastern White Cedar, Black Ash, Yellow Birch and other trees, *G. tessellata* plants grow on rotting logs and on the roots of trees among various swamp mosses.

LONG-LIVED COLONIES: Since 1975, we have monitored a colony of about a dozen rosettes of *G. tessellata* in Gatineau Park (Reddoch and Reddoch 1989). (A plant in this colony is illustrated in the Figure.) We discovered that the pattern on every leaf is different and thus we were able to follow the leaves in photographs of the colony from year to year. On this basis, we obtained the results described below under Vegetative Reproduction and Flowering Frequency. From computer simulations of the growth of this colony, based on an exponential growth model and on a random walk model, we estimated that the colony likely originated from a single rosette in the 1940s.

Until 1980, the colony thrived in heavy shade under a canopy of Eastern Hemlock, Sugar Maple, Yellow Birch and White Birch. In that year, some low-lying large trees shading the colony fell over as a result of a new beaver dam, thus exposing the colony to full afternoon sun and heat, and reducing ambient humidity and soil moisture. As a conse-

quence of these stresses, several changes occurred. The number of rosettes dropped from 21 to 5 in 1980. The colony persisted but with reduced vigour. After 1980, leaf lengths and inflorescence heights were two-thirds of their former sizes. The distance of new growths from the parent stem halved and the further distance travelled before flowering was also much less. On the other hand, neither the average number of leaves on a non-flowering rosette nor the number of new growths produced by a flowering rosette changed very much. Significantly, the time between the flowering of a parent and of its offspring decreased from a minimum of four years before 1980 to three years between 1980 and 1986, the last time that a plant flowered.

In 1989, after several hot, dry summers, there were four rosettes left. Continued dryness resulted in only one rosette remaining in 1990; it still survives to the present (1996). Our records show that this rosette appeared in the colony in 1983 and has never flowered, while continuing to produce an average of two new leaves per year.

Another long-lived colony of *G. tessellata* coexisting with *G. repens* and described under that species, has survived from at least 1978 to the present despite logging of the forest habitat.

EARLY HISTORY: Although *G. tessellata* was described in 1824, it was not until the turn of the 20th century that its status as a separate taxon was clarified (Kallunki 1976; Morris and Eames 1929). Thus it is not surprising that when early local botanists first collected it, they treated it as *G. repens*. *Goodyera tessellata* was not included in any of the early lists of the Ottawa Flora (Billings 1867; Fletcher 1880, 1893; Macoun circa 1911*). Macoun listed the DAO collection cited below under *G. repens*.

The first Ottawa District collections of this orchid were made in the late 1870s. James Fletcher collected it on 4 August 1877, from "Hull P.Q. near Ottawa" [DAO 96807] and on 8 August 1879, from "Stewart's Bush, Ottawa, Ont." [MTMG 47563] (with "Ottawa, Ont." of the same date [TRT 15499] a likely duplicate). In July of 1879, H. M. Ami collected this species at "Dom. Springs" (= Dominion Springs = Carlsbad Springs, Ontario; [MTMG 3419]), probably on the Ottawa Field-Naturalists' Club excursion there on 19 July.

In 1974, we examined a specimen of *G. tessellata* at the Canadian Forestry Service herbarium (OTF) at the Central Research Forest in Gloucester. M. L. Anderson had collected a flowering plant [Anderson 869] on 1 August 1974, from a group of two flowering and eight non-flowering rosettes. He directed us to the colony, located near the herbarium on the Dolman Ridge beside the Mer Bleue Bog in a heavily shaded hemlock forest on damp sand. The herbarium was moved to Petawawa and, subsequently

(1995), its contents were incorporated into the National Herbarium (CAN). At that time, this specimen could not be found (Albert Dugal, personal communication). The colony has not been seen in recent years.

VEGETATIVE REPRODUCTION AND FLOWERING

FREQUENCY: The year after flowering, a plant dies, but not before producing one or two, or occasionally three, new growths at an average distance of 2.3 cm from the parent. Each new growth generates two or three new leaves each year until the year it flowers. Each leaf lasts about two years. By the time a rosette reaches flowering size after a minimum of four years, it has at least three to five leaves and is now

about 3.5 cm from its parent. It does not produce any leaves the year it flowers. If a flowering stem is broken off at the base during flowering, the plant may not create any new growths. Occasionally a new rosette appears where there have been no recent flowering plants; it may be either a seedling or a growth from a non-flowering plant. (See Reddoch and Reddoch (1989) for further details on this colony.) On average, 24% of the rosettes flower in a given year. This is consistent with the four-year blooming cycle discussed above.

HYBRIDS: Kallunki (1976) has annotated two possible hybrids between *G. repens* and *G. tessellata* (see the account of the former species).

Liparis loeselii (Linnaeus) L. C. M. Richard

Loesel's Twayblade

Liparis de Loesel

In recent times *L. loeselii* has been widespread in many habitats, especially in wetlands and on moist sands. It shows considerable variation of stature according to its habitat. It can be recognized by its two basal, erect or arching, elliptical to lanceolate leaves and its several greyish green or greenish yellow flowers.

DESCRIPTION

Height: 4 (8 - 17) 29 cm [219 plants] (see Morphological Variation below regarding variation with habitat).

Flowers: 1 (3 - 10) 24 [164 plants]; greyish green in shady habitats to greenish yellow in sunny habitats; no odour detected.

Leaves: 2, rarely 3 [DAO 691473]; 2 on non-flowering plants; greyish green, usually long and arching in shade; yellowish green, short and erect in sun.

Overwintering State: as the corm of the current year.

Capsules: pale yellow to yellowish white, obovoid, typically 1.2 x 0.5 cm, erect or nearly so; yield usually greater than 40%, averaging 70% [89 plants].

Seeds: brownish orange, released in late September to late October.

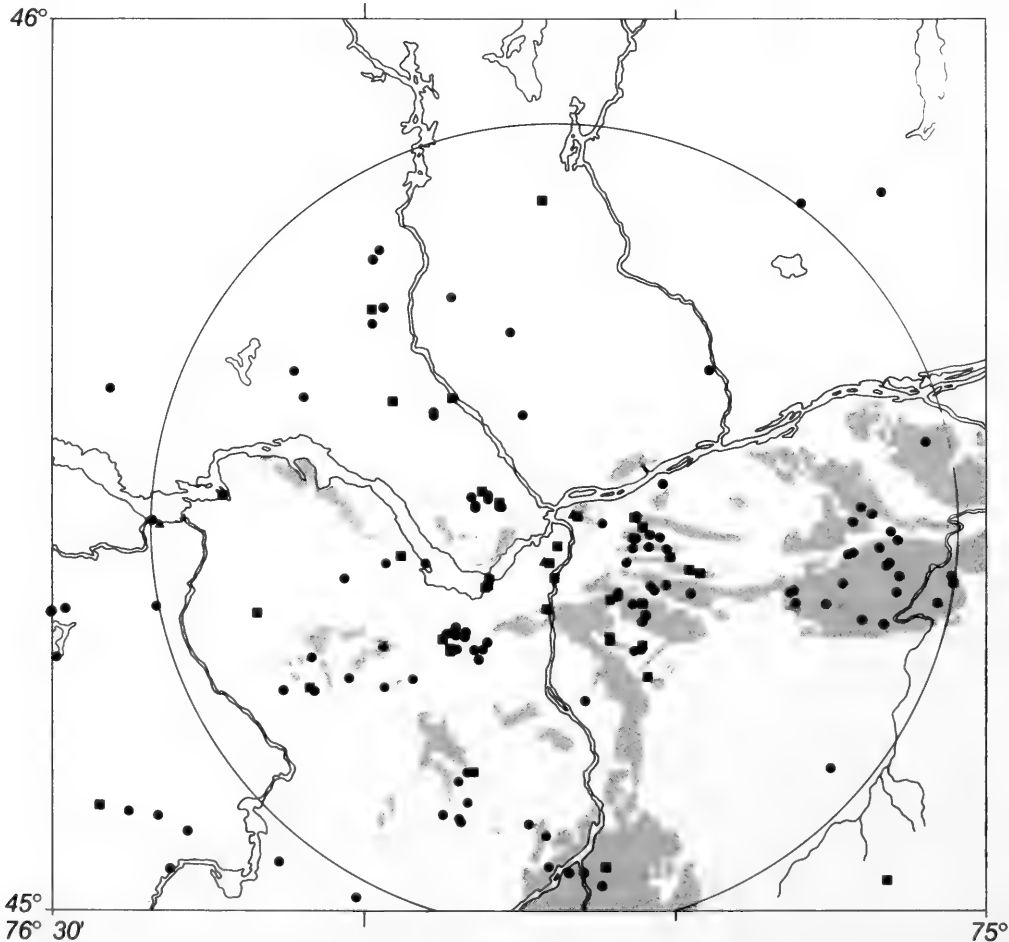
BLOOMING PERIOD: 9 June (18 June - 10 July) 2 August [72 records].

COLONY SIZES: 1 - 430, typically to 150, flowering and non-flowering plants [112 colonies], as scattered individuals and sometimes in small clumps.

DISTRIBUTION: The Ottawa District is at the northern edge of the range of this eastern species. It occurs predominantly in the Mixed Forest Region. Within the District, this orchid is thinly scattered on the Shield but is rather more common on the Lowlands, especially in areas of sandstone and of sand deposited by the Champlain Sea and subsequent rivers.

HABITATS: *Liparis loeselii* grows in many mesic to wet-mesic, semi-shaded to open habitats over a variety of bedrock types.

Relatively natural habitats include willow swales, alder thickets, coniferous and deciduous swamps,



Liparis loeselii: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record, ▲ = literature reference. Areas of major sand deposits on the Lowlands are shaded.



FIGURE 19. *Liparis loeselii*, left plant and flowers (mesic, open habit): height 13 cm, sandy borrow pit, Borthwick Ridge, Mer Bleue Conservation Area, Regional Municipality of Ottawa-Carleton, Ontario, 23 June 1970; right plant (wet-mesic shade habit): height 20 cm, cedar-ash swamp, Gatineau Park, Quebec, 19 July 1970. (The two plants are drawn to the same scale.)

forest stream edges and moist patches on forest floors. Open sedge fens and floating sedge mats are other naturally-occurring locations. In fens, the corms are lodged in peat among sedges and mosses, while in the other habitats they are supported in leaf-mould or among mosses on the ground or on rotting logs. In these latter habitats, there is generally little other vegetation except some mosses.

Like *Pogonia ophioglossoides*, *L. loeselii* occasionally grows on shoreline rotting logs that have fallen into the water (see Local History below). Both species also used to grow on floating boom logs on the Gatineau River (Bayly 1972, personal communication 1977, [CCO 3038]). (For additional details on these two habitats, see the *P. ophioglossoides* account.)

The disturbed habitats of open roadside ditches, old-fields and borrow pits harbour the majority of the District's colonies of this orchid. These habitats have in common that they are sandy and mesic to wet-mesic, with sparse vegetation and little shade. Most of the locations plotted on the distribution map in the Lowlands are such disturbed habitats. (See the accounts of *Calopogon tuberosus* and *Platanthera clavellata* for additional details of open sandy fields near the Mer Bleue Bog.)

LONG-LIVED COLONY: Wetlands and forests can be relatively stable and colonies of *L. loeselii* can persist in them for many decades. For instance, the plant of the wet-mesic shaded form illustrated grew near the edge of an Eastern White Cedar - Black Ash swamp in a colony that has continued from at least the late 1960s to the present.

LOCAL HISTORY: Braddish Billings Jr. collected *L. loeselii* on 9 July 1860 in Dow's Swamp and noted that it was rare there [QK 13217]. He did not include it in his list of plants collected in the summer of 1866 (Billings 1867). A number of other collections were made in and adjacent to Dow's Swamp between 1879 and 1953.

James Fletcher (1893) cited stumps and floating logs in the Rideau Canal as a habitat for *L. loeselii*. He made two collections on the edge of the canal at Patterson's Creek, in 1878 and 1879 [DAO 17766, 17769]. At that time it is likely that the banks of the 65-year-old canal were still relatively unimproved. Patterson's Creek is now an elongated pond running from the west bank of the canal almost to Bank Street, south of the Queensway.

Both James Fletcher (1893) and John Macoun (*circa* 1911*) knew of this orchid only from relatively natural habitats, except for one 1911 collection that Macoun listed from the roadside near the new entrance to Beechwood Cemetery. Fletcher (1893) considered this orchid to be "not uncommon".

Near Arnprior, Charles Macnamara (*circa* 1940*) described it as "scarce and local" in his caption of a 1913 photograph. In recent years, Runtz (1984) regarded it as common in the larger Arnprior area.

In 1953, W. G. Dore noted on his collection from the railway right-of-way adjacent to Dow's Swamp that *L. loeselii* was "scarce in the District". A dozen years later, members of the Native Orchid Location Survey began turning up colonies with some frequency, especially on the Lowlands in disturbed, open areas on sands and sandstone. It is likely that many of these habitats were created only in the 1960s with regrading of ditches, removal of sand for roadbuilding and abandonment of farming.

MORPHOLOGICAL VARIATION: We have observed, as have various authors, systematic variation in the stature of this orchid depending on its habitat. To study this variation more quantitatively, we classified the habitats as wet-mesic and shady (swamps), wet-mesic and open (fens), mesic and open (early succession, sandy, old-fields), and mesic and shady (transitional, sandy, old-fields). Of the two plants illustrated in the Figure, the larger is from a wet-mesic, shady habitat, while the smaller is from a mesic, open habitat.

The characters examined were plant heights, leaf lengths and numbers of flowers. We found that the variations in the numbers of flowers did not have a significant correlation with the habitats. However, the plant heights and the leaf lengths, although forming a continuum, did correlate significantly with the habitat type. The averages of these two characters were largest in the wet-mesic, shady sites and smallest in the mesic, open sites. For mesic, shady sites, the corresponding averages were intermediate between, and significantly different (5% level) from, those of the two former habitats. For wet-mesic, open sites, the averages suggested an intermediate position, but insufficient data prevented a more definitive account. The leaf length was nearly proportional to the plant height in all habitats and so the ratio of these two measurements did not vary greatly or significantly among habitats.

Morphological Variation with Habitat

average (range) [sample size]	mesic, open	mesic, shaded	wet-mesic, shaded
Height	9.2 (5 - 19) cm [87]	11.6 (8 - 18) cm [18]	15.2 (5 - 29) cm [73]
Leaf Length	5.7 (3.5 - 8.7) cm [6]	8.3 (5.5 - 10.3) cm [16]	10.3 (3.5 - 23) cm [59]
Number of flowers	8 (3 - 17) [18]	6 (1 - 13) [16]	6 (1 - 14) [67]

Plants in a colony can change in stature, apparently with changing light conditions. During the 1970s, we followed a colony in a borrow pit on the Borthwick Ridge beside the Mer Bleue Bog. At the beginning of the decade, the many plants grew on the open, mesic sand among sparse vegetation. These plants were of the mesic, open form. (One of the plants from this colony is shown in the Figure and the photograph of a 1969 clump accompanied an article on the Mer Bleue Bog (Dunston 1970).) By the end of the decade, the site was becoming overgrown with alders and other vegetation. The plants were now of the mesic, shaded form. (With increasingly complete shade, the colony disappeared within a few years.)

In conclusion, both the plant height and the leaf length are larger in the presence of more moisture and less light, but the flower number is not strongly dependent on these conditions. The morphology of plants in a colony changes with changing light conditions and likely with changing moisture regimes.

ABERRATION: A plant at the mesic, open Borthwick Ridge habitat described above had three flowers, the top two arising from between two floral bracts, side by side, and having fused pedicels and ovaries, but otherwise being complete. The flowers were erect with their lips touching each other.

Listera auriculata Wiegand

Auricled Twayblade

Listère auriculée

Listera auriculata, a small green-flowered plant of shaded stream banks, is an ephemeral member of the Ottawa flora, the only known colony having been discovered in 1967 and having survived for only a decade. It can be recognized by its two sub-opposite, sessile, cauline leaves and its several greenish flowers. The lip has essentially parallel sides and its apex has a small notch between two rounded lobes.

DESCRIPTION

Height: 8 - 12 cm [4 plants].

Flowers: 4 (6 - 12) 15 [18 plants]; greyish green at the centre of the lip, tending to a more greyish, translucent colour at the edges and on the petals and sepals.

Leaves: 2; 2 on non-flowering plants.

Overwintering State: a shoot 1 - 2 cm high at the base of the current year's stem below ground; herbarium specimens from elsewhere in Ontario and Quebec show the new shoot present at anthesis.

Capsules: light brown, ellipsoid to spheroid, typically 0.5 x 0.3 cm, ascending.

Seeds: orange white (from herbarium specimens elsewhere in Ontario and Quebec).

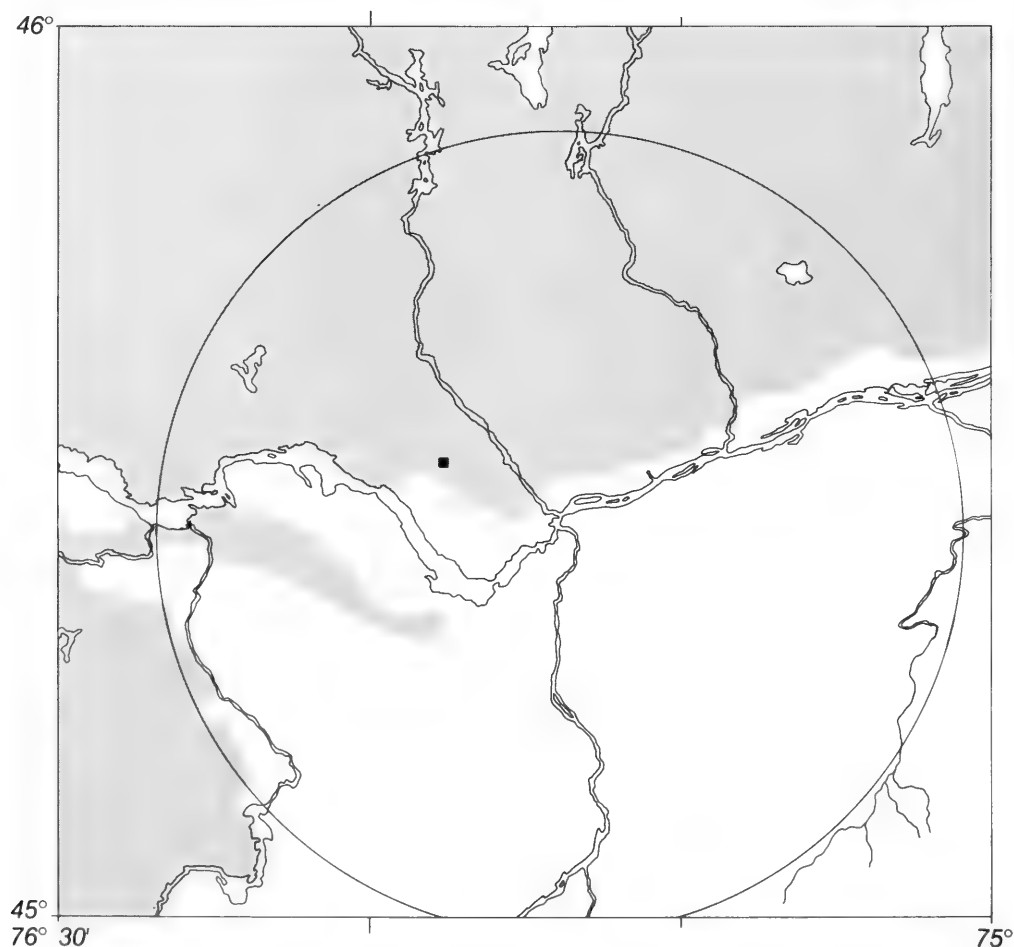
BLOOMING PERIOD: 14 June (16 June - 4 July) 9 July [9 records].

COLONY SIZES: to 162 flowering and non-flowering plants [1 colony], as scattered individuals and occasionally as pairs and small groups.

CURRENT STATUS: rare to uncommon (S3) in Ontario (Active List, Oldham 1996*); rare or extirpated in the Ottawa District (no extant colonies known).

DISTRIBUTION: The Ottawa District is near the southern edge of the range of this largely eastern Boreal Forest Region species. Within the District, one colony was located in Gatineau Park on the Canadian Shield in an area of porphyroidal gneiss bedrock (Hogarth 1970).

HABITAT: The plants were situated on the mesic to wet-mesic floodplain of a small stream in the dappled shade of fairly mature Eastern Hemlock, Yellow Birch and Sugar Maple. They grew in leaf-



Listera auriculata: ■ = herbarium specimen. The Canadian Shield is shaded.

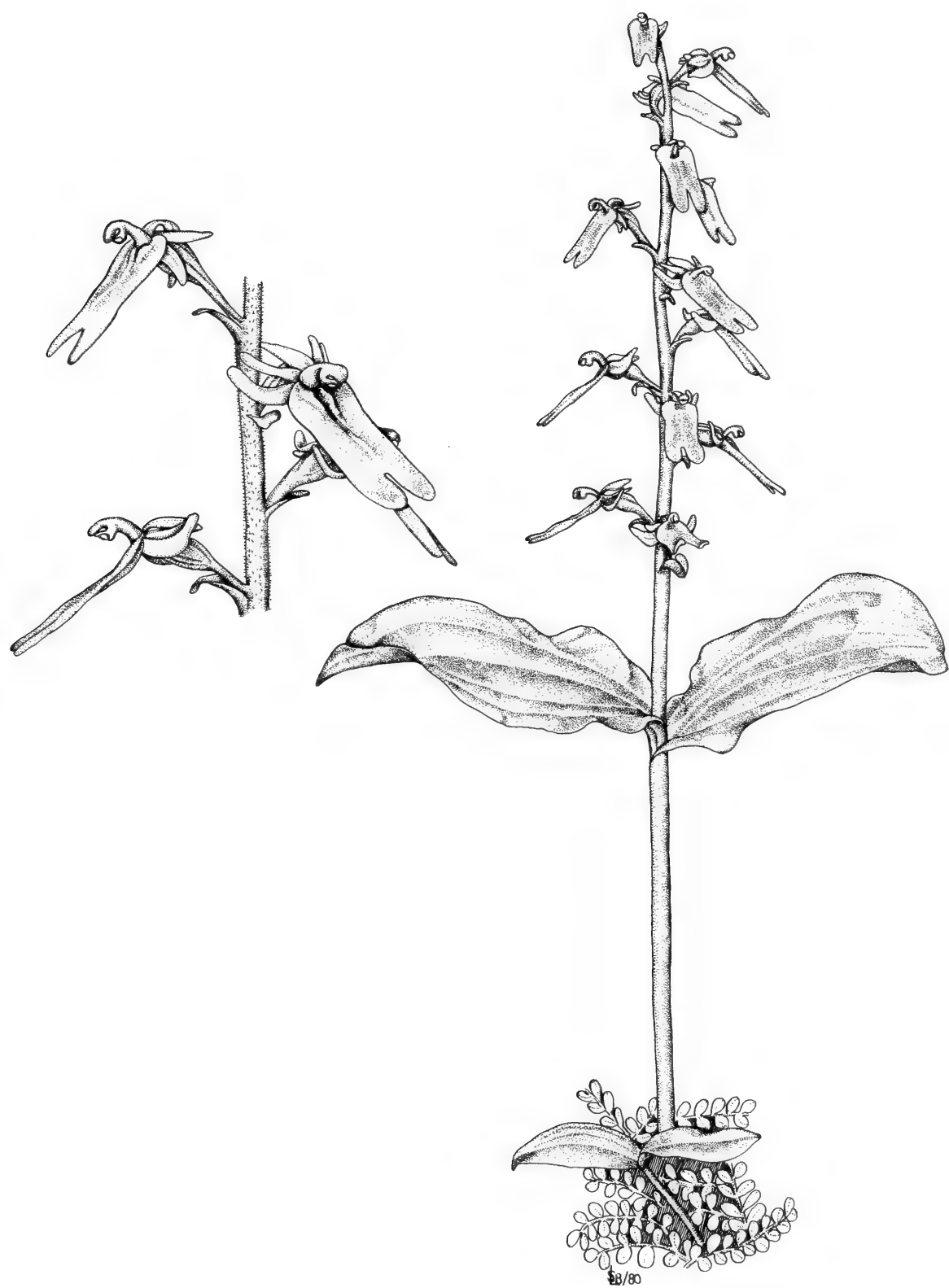


FIGURE 20. *Listera auriculata*, mixed forest - flood plain habitat, Gatineau Park, Quebec, 27 June 1970.

covered, sandy, alluvial soil and on rotting logs, stumps and tree roots among mosses; Stinging Nettle (*Urtica dioica*), Touch-me-not (*Impatiens capensis*) and Sugar Maple shoots were present at the edges of the colony.

LOCAL HISTORY: Hue MacKenzie discovered the first plant of *L. auriculata* on 16 September 1967, on an Ottawa Field-Naturalists' Club outing, which we also attended. The plant, with conspicuous capsules, was on a rotting log beside a rivulet running into Fortune Creek. The next June, Hue and members of the Native Orchid Location Survey confirmed the identity of the group of two flowering plants and one non-flowering plant (Greenwood 1968b; MacKenzie and Greenwood 1969). The photograph by Gary Hanes in the former reference shows the 1968 flow-

ering plant as well as its old flowering stems from the two previous years. From one to four plants appeared each year until 1973, except for 1971 when the terrain was flooded and no plants were visible.

In 1970, we encountered 162 plants on the floodplain of Fortune Creek about 100 m from the first group [DAO 600828, 691478]. About two-thirds of the plants produced flowers. This group declined to 11 plants in 1972 and was last seen in 1977. That year, there were three non-flowering plants along the stream edge about 50 cm above the stream bed. They were growing in a 30 cm-wide border of the moss *Atrichum undulatum*. Brunton and Crins (1975) reported several hundred plants in the general area of this colony in 1972. The relationship of this report to the plants described above is not clear.

Listera australis Lindley

Southern Twayblade

Listère australe

Listera australis is a tiny green and reddish orchid that grows in peatlands among mosses of similar colours. It was found in the Mer Bleue Bog at the end of the nineteenth century, but after about a decade was not seen again, there or elsewhere in the District. It can be recognized by its two sub-opposite, sessile, ascending, cauline leaves, its brown stem, and the reddish colour of the flowers. The lip has a very deep notch separating two long, pointed lobes. The sepals and petals are about 1/4 of the length of the lip and are strongly reflexed.

DESCRIPTION

Height: 14 - 21 cm [10 plants].

Flowers: 7 - 16 [10 plants]; red to brown with green depending on the proportions and concentrations of the pigments: lip brownish red to greyish ruby with greyish green or greyish yellow translucent centre, sepals and petals greyish green or greyish yellow with traces of red (colours based on Alfred Bog plants).

Leaves: 2.

Overwintering State: herbarium specimens show a shoot at the base of the current year's stem in the moss substrate; the new shoot is present at anthesis.

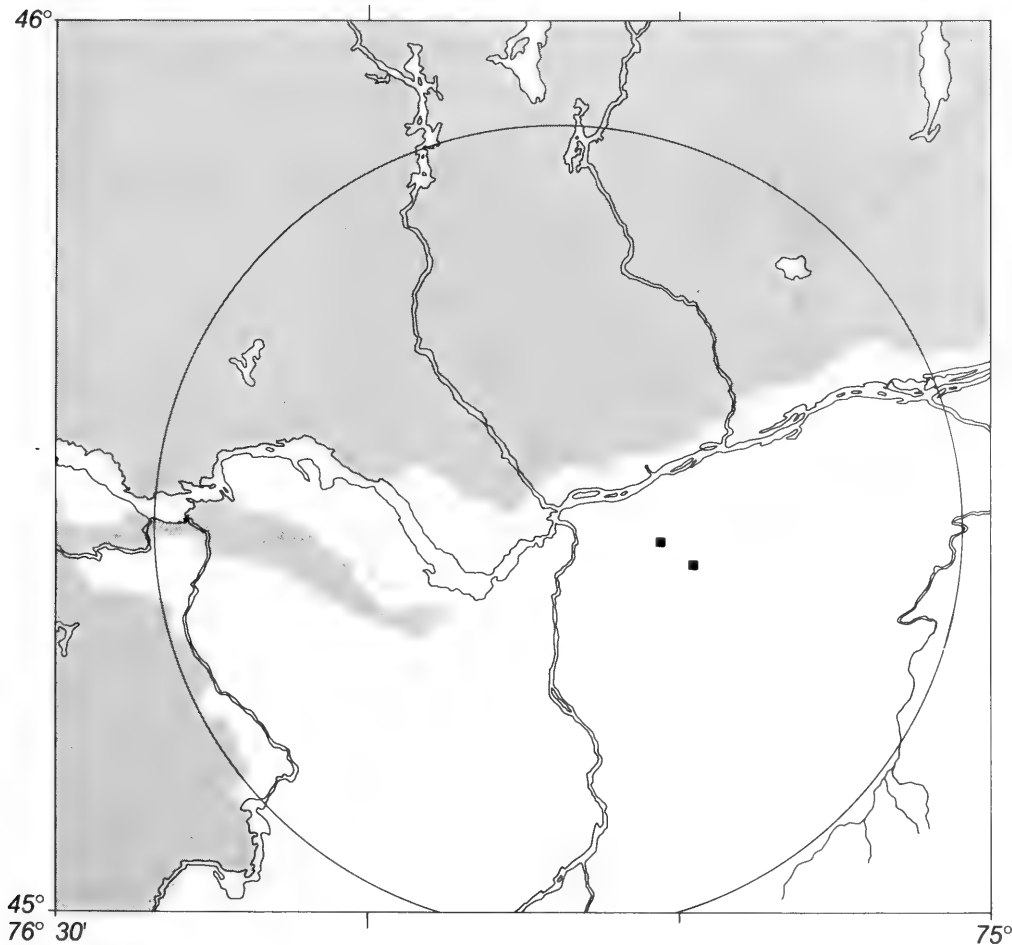
BLOOMING PERIOD: 28 May (3 June - 19 June) 21 June [7 records, including 4 from Alfred Bog].

COLONY SIZES: in Alfred Bog, over 40 flowering

plants in one part of the bog (Whiting and Bobbette 1974), as scattered individuals and in loose groups; difficult even to estimate given the inconspicuous nature of the plants and their widely scattered occurrence.

CURRENT STATUS: rare in the Provinces of Quebec (Bouchard et al. 1983) and Ontario (Catling, White et al. 1982), very rare (S2) in Ontario (Active List, Oldham 1996*), rare in Canada (Argus and Pryer 1990); apparently extirpated in the Ottawa District (no plants reported since 1902).

DISTRIBUTION: The Ottawa District is at the northern edge of the distribution of this orchid of southern Ontario and Quebec, New York State and coastal plain areas from Nova Scotia to the Gulf states (Catling, White et al. 1982). It is a species predomi-



Listera australis: ■ = herbarium specimen. The Canadian Shield is shaded.



FIGURE 21. *Listera australis*, poor fen habitat, Alfred Bog, Caledonia Township, United Counties of Prescott and Russell, Ontario, 14 June 1974.

nantly of the Southeastern Coastal Plain Forest Region.

Within the District, there were two colonies of *L. australis* in the Mer Bleue Bog a century ago. Elsewhere in the Ottawa Valley, there is a thriving population in various parts of the 4000 ha Alfred Bog, 20 km east of the edge of the Study Area.

HABITAT: In Alfred Bog, plants of *L. australis* are scattered through the sedge - shrub fen openings of the patterned bog community and in openings in the Black Spruce - Tamarack bog forest. (See Cuddy (1983) for a vegetation map of Alfred Bog and a description of the vegetation communities.)

The fen mats in the patterned bog are at least partially floating and there are many areas of open water. The orchids grow above the water level in wet *Sphagnum magellanicum* and *S. nemoreum*, on the fen floor and on the sides of hummocks around trees. There is little competing shrub cover where the orchid occurs; Three-leaved False Solomon's Seal (*Smilacina trifolia*) is almost the only other species sharing the patches of Sphagna, sometimes accompanied by Pitcher-plant (*Sarracenia purpurea*), Small Cranberry (*Vaccinium oxycoccos*) and Buckbean (*Menyanthes trifoliata*). Farther away, Pale Laurel (*Kalmia polifolia*) and Labrador Tea (*Ledum groenlandicum*) are common. (See Whiting and Bobbette (1974) for the report of the discovery of this orchid in Alfred Bog and for photographs and a description of the fen habitat. See Whiting (1974) and Reddoch (1983a) for additional background and for our photographs of this habitat.)

In the bog forest, *L. australis* plants grow on the flat Sphagna-covered floor among scattered sedges.

EARLY HISTORY: On 21 June 1893, James Fletcher

discovered *L. australis* for the first time in the Ottawa District and for the first time in Canada. He found "a bed of this rare little orchid" in the southern part of the Mer Bleue Bog, north of the Poplar Ridge (Poplar Island) near Eastman's Springs (Carlsbad Springs) (Whyte, Craig, and Cowley 1894, [CAN 116993, TRT 15703]). Ottawa Field-Naturalists' Club members again visited the colony on 28 May 1896 and found about a dozen plants in full flower (Fletcher 1896; Whyte, Craig, and Macoun 1897). The latter authors reported that specimens were collected; however, we have not been able to find a relevant collection in the herbaria that we visited. The naturalists also visited the colony in 1898 (Campbell, Macoun, and Whyte 1899).

On 20 June 1902, John Macoun (*circa* 1911*) collected *L. australis* from the northwest corner of the Mer Bleue Bog "amongst spruce trees ... about a mile east of Blackburn Station and half a mile south of the railway" [TRT 15701, MTMG 8596].

There have been no further reports of *L. australis* from the bog despite periodic searches. It is probable that fires and other disturbances such as various drainage schemes (Ashley 1979*) caused drastic changes in the habitats. Much of the burned area is now an expanse of ericaceous shrubs with Black Spruce and Tamarack making a comeback in some places.

ABERRATIONS: A plant with nine flowers that we collected at the Alfred Bog [DAO 691479] had two otherwise normal flowers side by side arising from a single broadened pedicel.

Another plant that we saw there had three leaves, one of them quite small and opposite a normal-sized leaf. A second normal-sized leaf grew about a centimetre below the small leaf.

Listera cordata (Linnaeus) R. Brown var. *cordata*

Heart-leaved Twayblade

Listère cordée

Listera cordata, a tiny, inconspicuous plant found in a few swamps, is the only *Listera* species currently known in the District. It can be recognized by its pair of spreading, cauline leaves and its flowers that have spreading sepals and petals about half as long as the lip. The narrow lip has a deep notch between two long, narrow, pointed, diverging lobes.

DESCRIPTION

Height: 7 (9 - 17) 22 cm [132 plants].

Flowers: 4 (6 - 12) 22 [123 plants]; sepals greyish green, lip and petals greyish green to brown; no odour detected.

Leaves: 2; 2 on non-flowering plants.

Overwintering State: a greyish green shoot, 1 - 1.5 cm high, at the base of the current year's stem in the moss substrate; herbarium specimens show the new shoot present at anthesis.

Capsules: greyish yellow, spheroid to ellipsoid, typically 0.3 x 0.2 cm, ascending (see Figure 1b); yield averaging 60% [11 plants], similar to the 70% yield reported from California (Ackerman and Mesler 1979).

Seeds: yellowish white, released in late June to early July while the flower parts are still fresh; this is

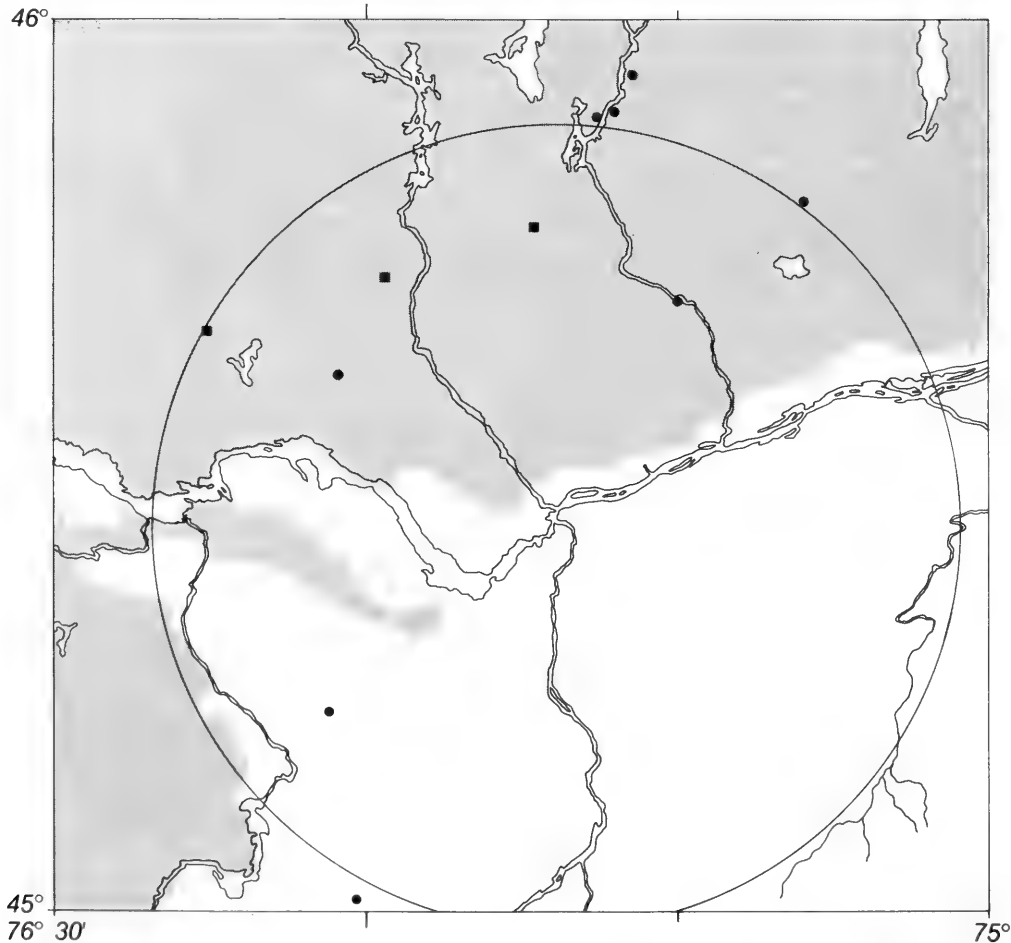
by far the earliest release of seeds of any Ottawa District orchid.

BLOOMING PERIOD: 4 June (10 June - 28 June) 13 July [14 records].

COLONY SIZES: 1 - 300 flowering plants [10 colonies], as scattered individuals and in loose groups.

DISTRIBUTION: The Ottawa District is well within the North American range of this transcontinental orchid. It is a species of the Montane, Boreal and Mixed Forest Regions. Within the District, *L. cordata* is thinly scattered across the Shield and in the Lowlands of the southwest.

HABITAT: *Listera cordata* is confined to semi-mature and mature coniferous swamps, usually in areas of calcareous bedrock. Plants occur in the



Listera cordata var. *cordata*: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record. The Canadian Shield is shaded.



FIGURE 22. *Listera cordata* var. *cordata*, coniferous swamp habitat, Val-des-Monts Municipality (Wakefield Township, Gatineau County), Quebec, 11 June 1975 (plant), 11 June 1978 (flowers).

shade of Eastern White Cedar and other trees such as Balsam Fir, Eastern White Pine, White Spruce, Black Spruce, Yellow Birch and Speckled Alder. They grow on mesic or wet-mesic swamp floors in leaf mould and in various mosses, including *Sphagnum magellanicum*, *S. fallax* and *Hylocomium splendens*, that may enclose the plants up to their leaves. Herbs and shrubs associated with this orchid include Bristle-stalked Sedge (*Carex leptalea*), Three-leaved False Solomon's Seal (*Smilacina trifolia*), Goldthread (*Coptis trifolia*), Labrador Tea (*Ledum groenlandicum*), Starflower (*Trientalis borealis*) and Twinflower (*Linnaea borealis*).

EARLY HISTORY: This species is not included in James Fletcher's *Flora Ottawaensis* of 1893 or in

any earlier list. John Macoun (*circa* 1911*) cited as his only record for *L. cordata* a collection that he made on 2 June 1898, "in a sphagnum swamp 3 miles west of North Wakefield". This description fits Chilcott's Swamp, the calcareous peatland at the edge of Johnston Lake, Quebec, first visited by botanists in the fall of 1892 (Whyte, Craig, and Cowley 1893). Although we have been unable to find this specimen, we found three others from this locality in local herbaria, collected in 1940, 1945 and 1960 [DAO 138637, 138638, CAN 386175].

ABERRATIONS: Rarely there is a small cauline bract between the leaves and the inflorescence. On one plant, in a swamp near Poltimore, Quebec, this bract was the size of a normal leaf.

Malaxis monophylla (Linnaeus) Swartz var. *brachypoda* (Gray)
Morris & Eames

White Adder’s-mouth

Malaxis à pédicelles courts

SYNONYMS: *Microstylis monophyllos* (Linnaeus) Lindley, *Malaxis brachypoda* (Gray) Fernald

Malaxis monophylla is a widely distributed, but not abundant, midsummer swamp orchid. It is a small and inconspicuous plant that becomes more noticeable after the light-coloured capsules have formed. It can be identified by its single, seemingly cauline leaf (which, in fact, sheaths the stem to the base) and by its numerous, very small flowers with pointed lips. In contrast to *M. unifolia*, the pedicels are no longer than the height of the flowers, resulting in a sparse, narrow inflorescence about 7 mm in diameter.

DESCRIPTION

Height: 8 (10 - 17) 25 cm [105 plants].

Flowers: 9 (18 - 34) 51 [41 plants]; yellowish white or pale white, sometimes light green or pale green; fragrance, none detected.

Leaf: 1, rarely with a second smaller, lower, opposite leaf, 1 on non-flowering plants.

Overwintering State: as the corm of the current year.

Capsules: pale orange, greyish orange or orange white, spheroid, typically 0.5 x 0.3 cm, ascending (see Figure 1b); yield highly variable, averaging

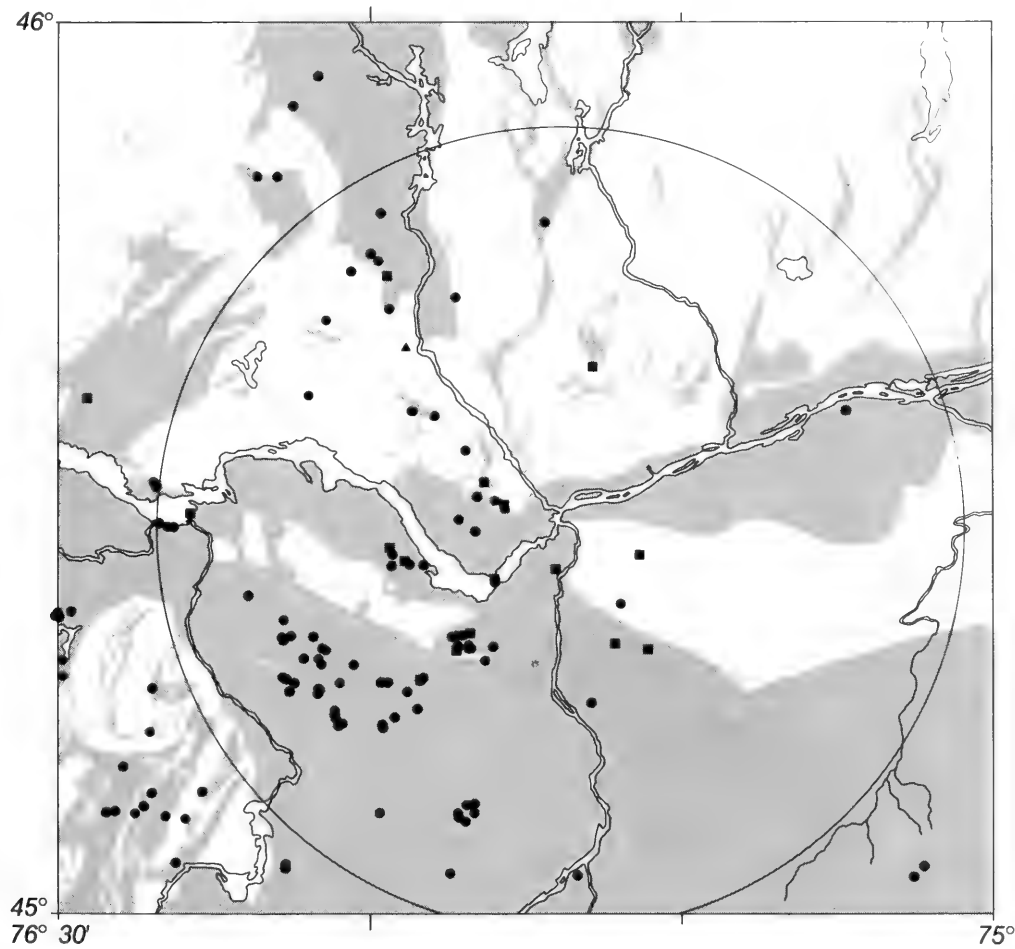
40% [29 plants].

Seeds: orange white, released in early October.

BLOOMING PERIOD: 8 June (23 June - 15 July) 29 July [38 records].

COLONY SIZES: 1 - 275, typically to 50, flowering plants [117 colonies], generally as scattered individuals.

DISTRIBUTION: The Ottawa District is near the northern edge of the distribution of this mainly eastern orchid. It is a species of the Mixed Forest Region and adjacent Boreal Forest Region. It is widespread



Malaxis monophylla var. *brachypoda*: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record, ▲ = literature reference. Major areas underlain by calcareous rock (marble and limestone) are shaded.



FIGURE 23. *Malaxis monophylla* var. *brachypoda*, plant: cedar - ash swamp habitat, Gatineau Park, Quebec, 1 July 1975; flowers: cedar swamp, Goulbourn Township, Regional Municipality of Ottawa-Carleton, Ontario, 21 June 1970.

in the calcareous regions of the District, chiefly in the southwest and in the Gatineau Valley.

HABITATS: *Malaxis monophylla* usually grows in partially to deeply shaded, moist to wet swamps and low-lying woods. At least a few plants are present in most calcareous swamps in the District, especially swamps dominated by Eastern White Cedar and Black Ash. Rarely, this species also occurs in Silver Maple swamps.

In swamps, the orchid corms are lodged in leaf mould or in moist to wet organic soil, often among mosses. Where the swamp floor is very wet, the plants grow on mounds around trees and over tree roots, as well as on rotting logs. There may be no other companion plants or there may be such typical swamp vegetation as Cinnamon Fern (*Osmunda cinnamomea*), Oak Fern (*Gymnocarpium dryopteris*), Jack-in-the-pulpit (*Arisaema triphyllum*), *Coral-lorhiza trifida*, *Cypripedium reginae*, *Platanthera hyperborea*, Naked Mitrewort (*Mitella nuda*), Foamflower (*Tiarella cordifolia*), Water Avens (*Geum rivale*), Wood-sorrel (*Oxalis acetosella*),

One-flowered Wintergreen (*Moneses uniflora*), One-sided Pyrola (*Orthilia secunda*) and Twinflower (*Linnaea borealis*).

Once in a while, a few plants are encountered in moist to wet situations in willow swales, alder thickets and stream edges, as well as on somewhat drier ground in moist coniferous and mixed forests. Rarely a few plants are found in fens.

Where *M. monophylla* and *M. unifolia* occur together, the former species is usually in the lower and wetter parts of the moisture gradient.

EARLY HISTORY: Early naturalists knew of *M. monophylla* at only a few locations and considered it rare in the District (Fletcher, Scott, and Cowley 1892; Fletcher 1893). James Fletcher made the first collections in Dow's Swamp in 1878 [DAO 17822, MTMG 47282], where it grew "in large numbers" along with two other rare orchids, *Amerorchis rotundifolia* and *Cypripedium arietinum* (Whyte and Small 1883; Fletcher, Scott, and Cowley 1892). John Macoun (circa 1911*) was not acquainted with this species in the District.

Malaxis unifolia Michaux

Green Adder's-mouth

Malaxis unifolié

SYNONYM: *Microstylis ophioglossoides* (Muhlenberg) Nuttall

Malaxis unifolia is a widespread and relatively common, if inconspicuous, orchid found in a wide variety of habitats. It can be recognized by its single, sheathing, cauline leaf and its numerous tiny greenish flowers. In contrast to *M. monophylla*, the pedicels are notably longer than the height of the flowers. As a result, the flat-topped, dense inflorescence is at least 1 cm in diameter. The lip has a distinct notch at the apex, often containing a small point.

DESCRIPTION

Height: 6 (10 - 17) 23 cm [250 plants] (see also Notable Plant below).

Flowers: 10 (16 - 49) 80 [58 plants]; greyish green like the rest of the plant or greenish yellow with centre of lip greyish green; fragrance lacking or mild and sweet; flower orientation somewhat irregular, especially for the lower flowers.

Leaf: 1, rarely 2, one clasping the other at mid-stem, 1 on non-flowering plants.

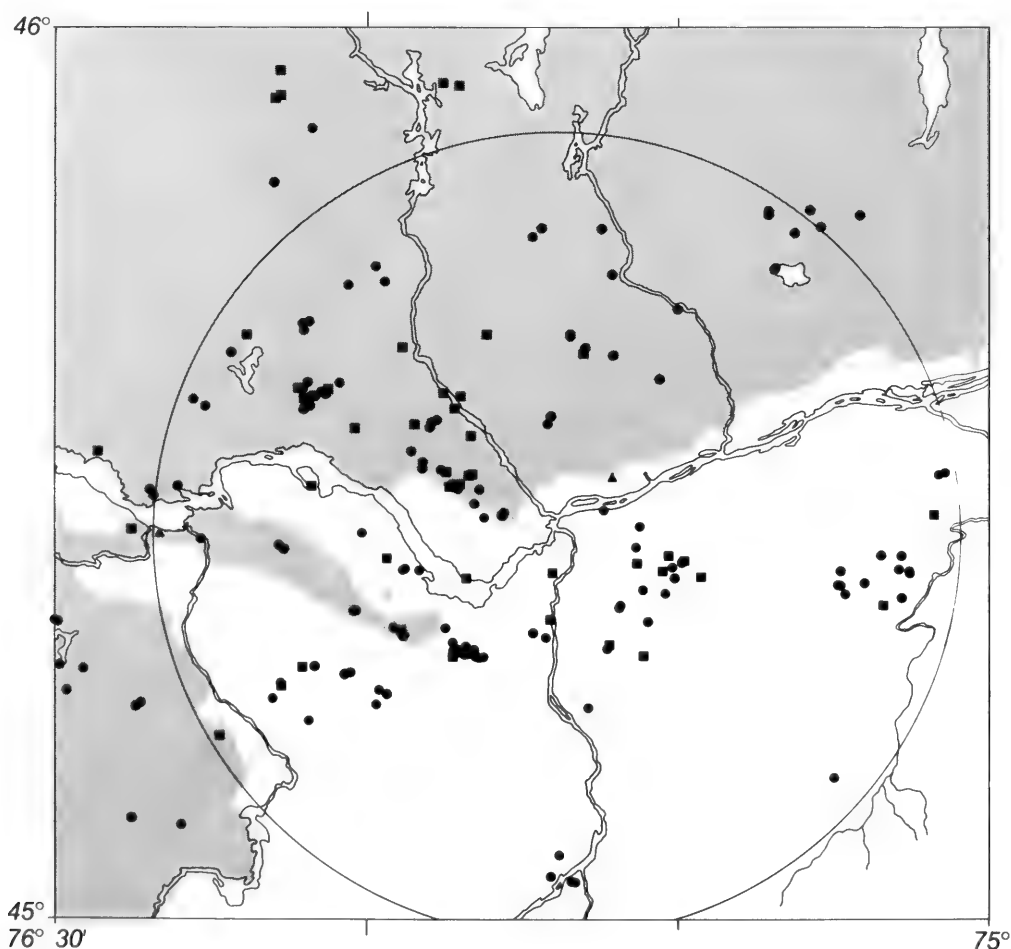
Overwintering State: as the corm of the current year.

x 0.25 cm, horizontal to ascending; yield usually less than 40%, averaging 15% [83 plants].

Seeds: greyish orange, released in mid to late September.

BLOOMING PERIOD: 16 June (2 July - 30 July) 19 August [105 records].

COLONY SIZES: 1 - 150, typically to 60, flowering plants; 10 or fewer in 74% of colonies; one exceptional colony in the Constance Creek valley, West Carleton Township, Ontario, with 1100 plants in 1968 (Hue MacKenzie, records of the Native Orchid Location Survey) [141 colonies]; generally as scat-



Malaxis unifolia: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record, ▲ = literature reference. The Canadian Shield is shaded; areas underlain by sand and sandstone are omitted for clarity.

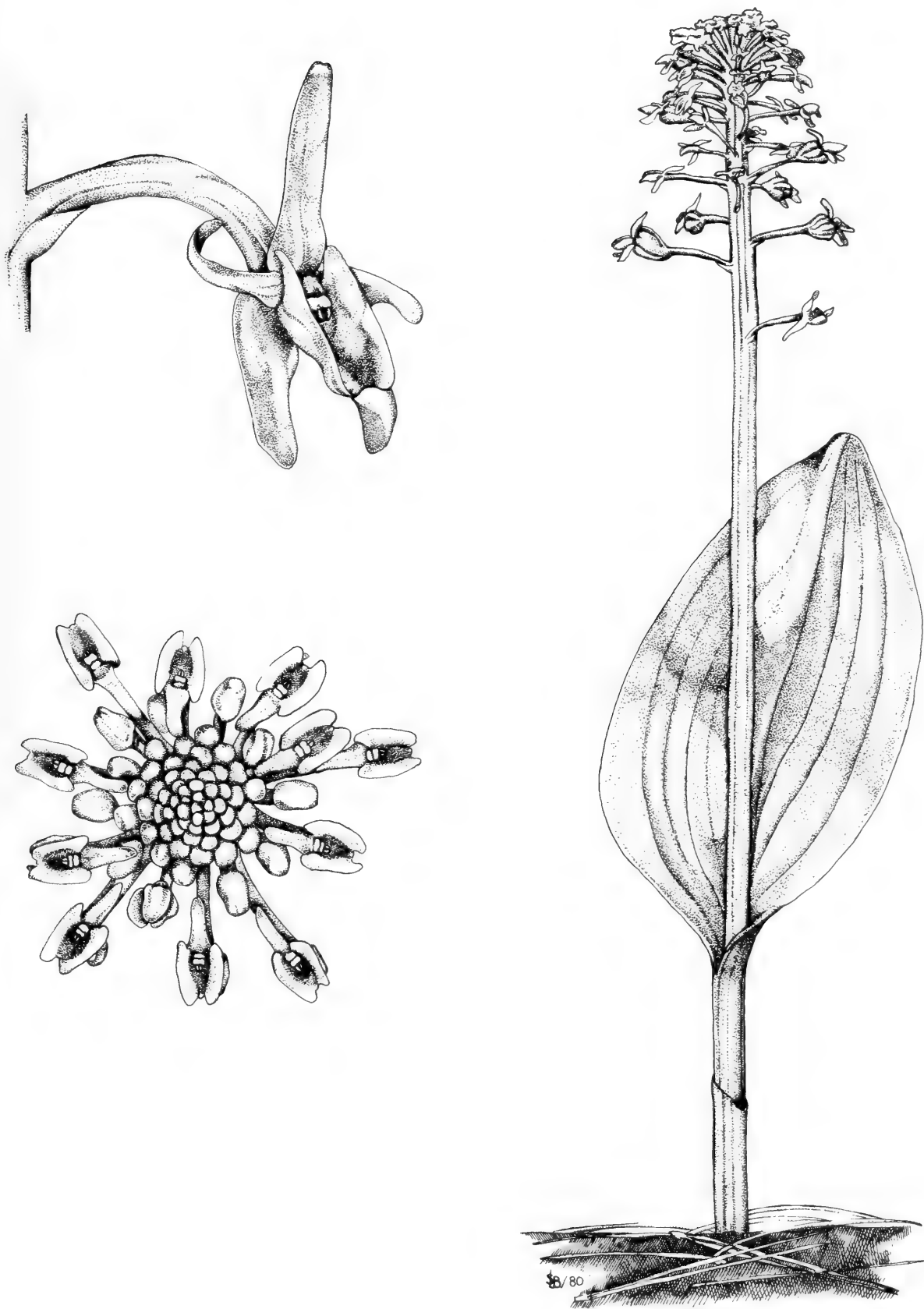


FIGURE 24. *Malaxis unifolia*, plant: pine plantation habitat, Larose Forest, Cambridge Township, United Counties of Russell and Prescott, Ontario, 26 July 1969; single flower and top view of inflorescence: sandy old-field habitat, Mer Blue Conservation Area, Regional Municipality of Ottawa-Carleton, Ontario, 23 June 1970.

tered individuals and occasionally in clumps of up to a dozen flowering and non-flowering plants.

CURRENT STATUS: A century ago this species was considered to be rare in the District (Fletcher 1893). Perhaps its abundance has been enhanced in the latter half of this century by the increased number of disturbed sites on sand.

DISTRIBUTION: The Ottawa District is in the northern part of the range of this eastern species. In North America it inhabits the Mixed and Deciduous Forest Regions. It is also found in parts of Mexico, Central America and the Caribbean (Catling 1991). This orchid is widely scattered across the District, especially in areas of acidic rock and of sand left by the Champlain Sea and subsequent rivers.

HABITATS: *Malaxis unifolia* occurs in a variety of habitats, from dry hilltops to moist swamps, under open sun to deep shade. The most common soil substrate is sand or sandy loam.

Plants are perhaps most often encountered growing in thin sandy soil on open or partially shaded Precambrian knolls or on expanses of flat-lying sandstone. They are also frequent in recently disturbed, open areas of mesic sand amongst sparse vegetation (see description of Dolman Ridge habitat of *Calopogon tuberosus*).

Colonies also become established on the bare ground of heavily-shaded coniferous forests and pine plantations (see description of Larose Forest colony of *Cypripedium acaule*). Shady deciduous forests and more-open forest edges also support colonies on occasion. Sometimes there are a few plants in semi-open forests at the shores of rivers and small lakes.

In the wet-mesic to wet conditions of cedar swamps, plants tend to stay above wet swamp floors on rotting logs and on mounds around the bases of trees (see account of *M. monophylla* above).

Although most habitats occupied by *M. unifolia* are sandy and acidic, there is the occasional site that is neither (see description of The Burnt Lands colony of *Cypripedium arietinum* in clay soil over limestone).

EARLY HISTORY: Braddish Billings Jr. collected *M. unifolia* "on the nearly perpendicular slope of King's Mountain" in what is now Gatineau Park on 10 July 1860 [QK 13271]. Another early collection at Queen's University is that of John Kerr McMorine in 1862 from Ramsay, Ontario [QK 66701].

James Fletcher made collections near Dominion Springs (now Carlsbad Springs) in 1879 [DAO 17835, MTMG 47291, TRT 15728] and from Dow's Swamp in 1880 [DAO 17835]. At Dow's Swamp, R. B. Whyte, and H. B. Small (1883) reported only one plant in 1882 and thought it curious that in previous years it had been as plentiful there as *M. monophylla*. By 1893 James Fletcher knew of it only from Dominion Springs, Dow's Swamp and Aylmer, and regarded it as rare.

NOTABLE PLANT: In August of 1995 we found in the Larose Forest a plant 35 cm tall growing out from between two Red Pine logs lying on the ground. Of that height, 13 cm of the stem was hidden from view, passing between the logs to the corm sitting on the sandy ground beneath. The previous year's flowering stem was present beside it. A month later the logs had been removed and there was no evidence of the plant.

Platanthera blephariglottis (Willdenow) Lindley var. *blephariglottis*

(Northern) White Fringed-orchid

Platanthère à gorge frangée

SYNONYM: *Habenaria blephariglottis* (Willdenow) Hooker

This orchid is one of our rarest, having been recorded only from three very wet peatlands in the District. It is fairly conspicuous, however, with its clusters of white flowers standing just above the sedges and other wet-land plants. It is easy to identify by its habitat and by its brilliant white flowers with short-fringed single-lobed lips.

DESCRIPTION

Height: 11 (26 - 39) 50 cm [148 plants], significantly shorter than the 100 cm reported by Case (1987) for Michigan, southwestern Ontario and Ohio.

Flowers: 3 (7 - 20) 35 [48 plants]; white on all parts, sometimes with pale yellow at end of spur; column white with pale yellow from the pollinia showing through the anther sacs; pedicel often white at top, blending into pale yellow or pale green at base; inflorescences with few flowers appearing globular or irregular, those with more flowers becoming more cylindrical; fragrance none or faintly spicy during day and early evening.

Leaves: 2, sometimes 3, grading into cauline

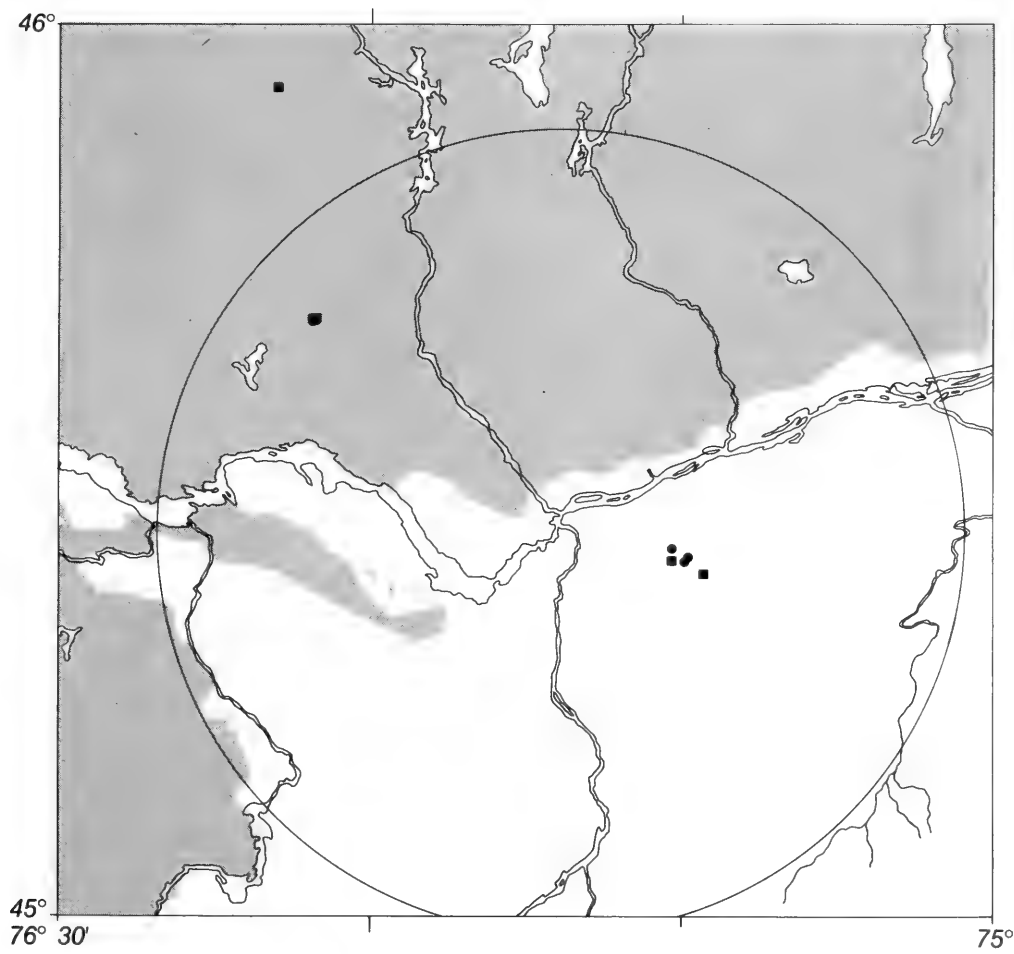
bracts for a total of 3 - 5 leaves and bracts; one leaf on non-flowering plants.

Overwintering State: a greyish green shoot beside the current year's stem in the moss substrate, rising from the stem or from a horizontal root up to 1 cm from the base; herbarium specimens show the new shoot and partially elongated roots present at anthesis.

Capsules: light to dark brown, ellipsoid, typically 1.2 x 0.3 cm, ascending (see Figure 1b); yield approaching 100% on 5 plants.

Seeds: light brown to brown, released in late September to early October.

BLOOMING PERIOD: 12 July (18 July - 5 August) 16 August [21 records].



Platanthera blephariglottis var. *blephariglottis*: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record. The Canadian Shield is shaded.



FIGURE 25. *Platanthera blephariglottis* var. *blephariglottis*, poor fen habitat, Mer Bleue Conservation Area, Regional Municipality of Ottawa-Carleton, Ontario, 19 July 1973.

COLONY SIZES: 3 - 100 flowering plants [9 records from two peatlands], as scattered individuals or occasionally in groups of two or three.

CURRENT STATUS: rare in the Provinces of Quebec (Bouchard et al. 1983) and Ontario (White et al. 1982b), rare to uncommon (S3) to common (S4) in Ontario (Watch List, Oldham 1996*); rare in the Ottawa District.

DISTRIBUTION: The Ottawa District is near the northern edge of the distribution of this northern variety of *P. blephariglottis*. This variety occurs primarily in the Mixed Forest Region (Catling 1983b). Within the District, *P. blephariglottis* has been found in several parts of the Mer Bleue Bog and in two small peatlands on the Canadian Shield. Elsewhere in the Ottawa Valley, a colony occurs in the patterned bog - fen complex of Alfred Bog, 20 km beyond the eastern edge of the Study Area (Cuddy 1983).

HABITAT: This species is confined to minerotrophic areas in certain bogs that can be categorized as poor fens. The largest colonies thrive in sunny openings near scattered Black Spruce and Tamarack where the *Sphagnum*-covered fen floor is very wet and loosely consolidated. Shrubs are thinly scattered or absent and sedges are the most common herbs. Large patches of Bog Rosemary (*Andromeda glaucophylla*) and numerous plants of Three-leaved False Solomon's Seal (*Smilacina trifolia*) are frequent. Small Cranberry (*Vaccinium oxycoccos*) is often present and *Sphagnum magellanicum* is the most abundant moss. Leatherleaf (*Chamaedaphne calyculata*) and Labrador Tea (*Ledum groenlandicum*) are occasional shrubs, especially close to the trees.

We observed that as one site in the Mer Bleue became somewhat drier, shrubbier and more bog-like, it supported fewer and fewer plants. A colony of 95 flowering plants in 1973 had decreased to three flowering plants in 1994. A few dozen flowering plants of *Cypripedium acaule* continue to persist there.

LOCAL HISTORY: Ottawa Field-Naturalists' Club botanists began to explore the Mer Bleue in July of 1879 and *P. blephariglottis* was one of the first of many rarities to be discovered there. It was collected that July by Henry M. Ami [DAO 17057, MTMG 3388, TRT 15508] and by James Fletcher [CAN 116937], near Eastman's (Carlsbad) Springs (Macoun circa 1911*). Sporadic collections followed from the southern and western edges of the bog. In 1971, Don Lafontaine and David White discovered 87 flowering plants out in the middle of the peatland (Lafontaine 1971).

In 1963, W. G. Dore collected a plant, one of a small number, from a "sphagnous bog mat around a small lake" near Danford Lake west of Kazabazua, Quebec [Dore 20359 at DAO]. Somewhat closer to Gatineau Park, Monty and Grace Wood (personal communications 1976, 1996) discovered this orchid on their newly purchased property near St.-François-de-Masham, west of Wakefield, in 1970. Several hundred flowering plants were scattered on a partially floating, poor fen bordering a pond [DAO 691514]. Similar numbers continue to flourish there (Monty Wood, personal communication 1996). This habitat is illustrated on the front cover of the fourth-quarter issues of *Trail & Landscape* (Reddoch 1988).

Platanthera clavellata (Michaux) Luer var. *clavellata*

Club-spur Orchid

Platanthère claviforme

SYNONYMS: *Habenaria clavellata* (Michaux) Sprengel, *Habenaria tridentata* (Muhlenberg) Hooker

Platanthera clavellata is neither abundant nor conspicuous. It can be identified by the single cauline leaf at or somewhat below the centre of the narrow, ridged stem, the rather irregular arrangement of the flowers and the three rounded teeth at the end of the otherwise undivided and unfringed lip.

DESCRIPTION

Height: 10 (18 - 27) 36 cm and 46 cm (see Notable Plant below) [311 plants].

Flowers: 1 (3 - 10) 26 [180 plants]; pale green, pale yellow or white, sometimes greyish green along centre line on outside of dorsal sepal and at end of spur; irregularly arranged as a result of incomplete rotation about the pedicellate ovary, appearing to lie on their sides, often facing in a common direction toward the stronger light; when there are more flowers, the inflorescence becomes more regular; fragrance mild and sweet or none.

Leaves: 1, occasionally 2 on robust plants, the upper one much reduced, with 2 small bracts above; 1 leaf on non-flowering plants.

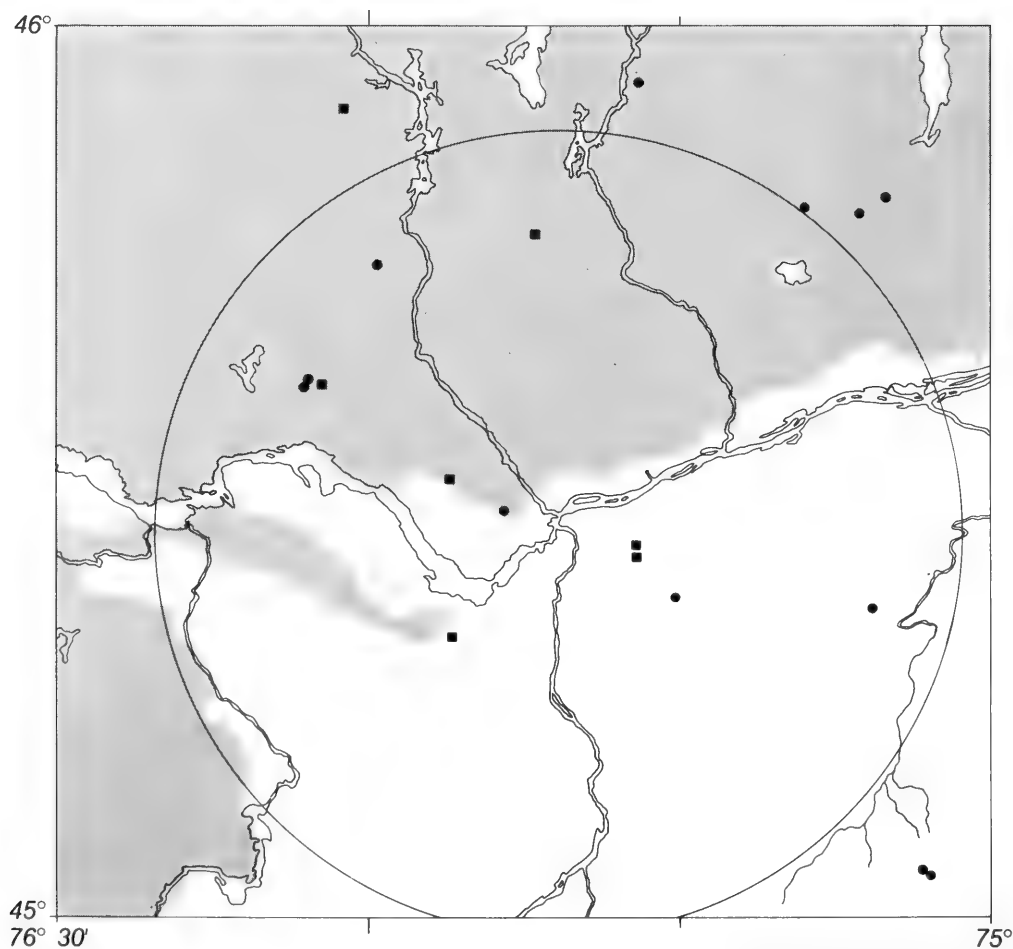
Overwintering State: a greyish green shoot, 1.5 -

2 cm tall, 1.5 mm diameter, the tip just below ground or moss substrate level in early fall, rising from a horizontal root about 2 cm away from the current year's stem; herbarium specimens show the new shoot present at anthesis.

Capsules: brown, ellipsoid, typically 0.8 x 0.4 cm, ascending irregularly; yield approaching 100% for three-quarters of the plants, highly variable for the remainder, averaging 85% [44 plants], plants susceptible to predation by White-tailed Deer, especially in Gatineau Park.

Seeds: light brown, released in mid September to early October.

BLOOMING PERIODS: 5 July (11 July - 6 August) 17 August [28 records].



Platanthera clavellata var. *clavellata*: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record. The Canadian Shield is shaded.



FIGURE 26. *Platanthera clavellata* var. *clavellata*, old-field habitat beside Black Lake, Gatineau Park, Quebec, 18 July 1970.

COLONY SIZES: 2 - 77, typically to 50, flowering plants [17 colonies], as scattered individuals and occasionally in groups of from two to as many as nine flowering stems.

DISTRIBUTION: The Ottawa District is in the northern part of the range of this eastern orchid, which is predominantly in the Mixed and Deciduous Forest Regions. Within the District, *P. clavellata* is thinly spread across the Canadian Shield and the Lowlands.

HABITATS: Two types of habitats provide suitable environments for *P. clavellata*: moist, sandy, old-fields and openings, and the borders of peatlands, swamps and lakes. Old-fields, openings and lakeshores generally provide short term habitats, while peatlands and swamps are more likely to offer stable conditions for decades or longer.

In old-fields and openings, plants favour light to medium shade adjacent to (and sometimes well under) trees and shrubs. Depending on the amount of shade, plants may be accompanied by any mixture of old-field herbs, including Field Horsetail (*Equisetum arvense*), Marsh Fern (*Thelypteris palustris*), *Liparis loeselii*, Wild Strawberry (*Fragaria virginiana*), Dewberry (*Rubus hispidus*), Heal-all (*Prunella vulgaris*), Indian Tobacco (*Lobelia inflata*), Yarrow (*Achillea millefolium*), goldenrods (*Solidago* spp.) and various grasses. Occasionally, Royal Fern (*Osmunda regalis*), *Malaxis unifolia* and *Platanthera lacera*, as well as patches of *Sphagnum* and *Polytrichum* mosses are present. A pH of 5.0 was measured in two colonies near the Mer Bleue.

In peatlands, usually fens, colonies are sometimes encountered on the open sedge mat near the border with the adjacent swamp, growing in *Sphagnum magellanicum* and other minerotrophic Sphagna in the light shade of Tamarack and Labrador Tea (*Ledum groenlandicum*). A pH of 4.5 was measured at the roots in the Sphagna of one fen.

LONG-LIVED COLONY: A colony of a few dozen plants that we have followed since 1968 flourishes along the moist edge of a White Cedar - Black Ash swamp over marble bedrock in Gatineau Park. The plants grow on mossy hummocks (pH 5.3) in dappled shade along with Bristly Clubmoss

(*Lycopodium annotinum*), Cinnamon Fern (*Osmunda cinnamomea*), Royal Fern (*O. regalis*), Bluebead-lily (*Clintonia borealis*), Goldthread (*Coptis trifolia*), Wild Sarsaparilla (*Aralia nudicaulis*), Bunchberry (*Cornus canadensis*), Starflower (*Trientalis borealis*), Red Maple seedlings and other swamp species. Some plants grow equally well a metre away from the swamp edge in the mesic leaf mould of the adjacent mixed forest with Rattlesnake Fern (*Botrychium virginianum*), Bluebead-lily, Wild Lily-of-the-valley (*Maianthemum canadense*), Wild Sarsaparilla, Sugar Maple seedlings and other mesic forest inhabitants.

EARLY HISTORY: James Fletcher collected *P. clavellata* in a "tiny bog" (Fletcher 1893) at Black Lake in what is now Gatineau Park on 8 July 1878 [DAO 267278, MTMG 47571]. He was referring, perhaps, to the small, partially-floating, poor-fen mat that persisted at the southeast corner of the lake until recent times. (The mat was mostly flooded by Beavers in 1983 (J. M. Reddoch and A. H. Reddoch 1987d)). He collected *Pogonia ophioglossoides* there on the same day.

We have not found *P. clavellata* on the fen mat, but in the late 1960s and early 1970s we did encounter some 50 flowering plants on the north shore of the lake, about 100 m away from the mat, in moist, old-field conditions. They are no longer there. One of these plants is depicted in the Figure.

From 1878 until 1950, no additional collections seem to have been made in the District.

NOTABLE PLANT: In 1970, we encountered and photographed a strikingly large plant that grew in the Eastern White Cedar - Black Ash Swamp described above. One of a group of eight medium to large plants, it was 46 cm tall with two leaves and 26 flowers, 30% taller and with 50% more flowers than the next largest plants in the District. The inflorescence was cylindrical in shape. Unlike most plants, its flowers, except for the lowermost ones, were arranged in four nearly vertical ranks with lips downward, giving the appearance of a small *P. orbiculata*. We have not seen a comparable plant at that site or at any other.

Platanthera dilatata (Pursh) Lindley ex Beck var. *dilatata*

Fragrant White Orchid

Platanthère dilaté

SYNONYM: *Habenaria dilatata* (Pursh) Hooker

An inhabitant of some of our fens, but not of our bogs, *Platanthera dilatata* is a striking, tall, white-flowered plant that justifies the second part of its other common name, Bog Candles. It can be recognized by its narrow, dense inflorescence of pure white, fragrant flowers with narrow lips and short spurs.

DESCRIPTION

- Height:** 27 (38 - 61) 77 cm [167 plants].

Flowers: 9 (11 - 40) 65 [24 plants]; white, sometimes becoming greyish green toward the tip of the spur and at bases of sepals; arranged in dense or loose inflorescences sometimes showing evidence of spiral structure; fragrance spicy, often strong; Luer (1975) included a photograph (Plate 60, #1) of an inflorescence in the open sedge fen near Poltimore, Quebec, to illustrate this species.

Leaves: 5 to 8 leaves and bracts.

Overwintering State: a greyish green, narrowly conical shoot, appearing above ground beside the current year's stem in late September; herbarium specimens show the new shoot and partially elongated roots present at anthesis.
- Capsules:** light brown, ellipsoid, typically 0.8 x 0.35 cm, ascending to erect (see Figure 1b); yield variable, averaging 60% [9 plants].

Seeds: light brown, released in mid to late August.

BLOOMING PERIOD: 8 June (20 June - 22 July) 10 August [40 records].

COLONY SIZES: 1 - 190 flowering plants [12 colonies], as scattered individuals and, rarely, in small groups.

DISTRIBUTION: The Ottawa District is in the southern part of the eastern range of this primarily north-eastern and western species. In the east, it is mainly a plant of the Boreal and Mixed Forest Regions. Within the District, *P. dilatata* is confined to fens in areas of calcareous bedrock.

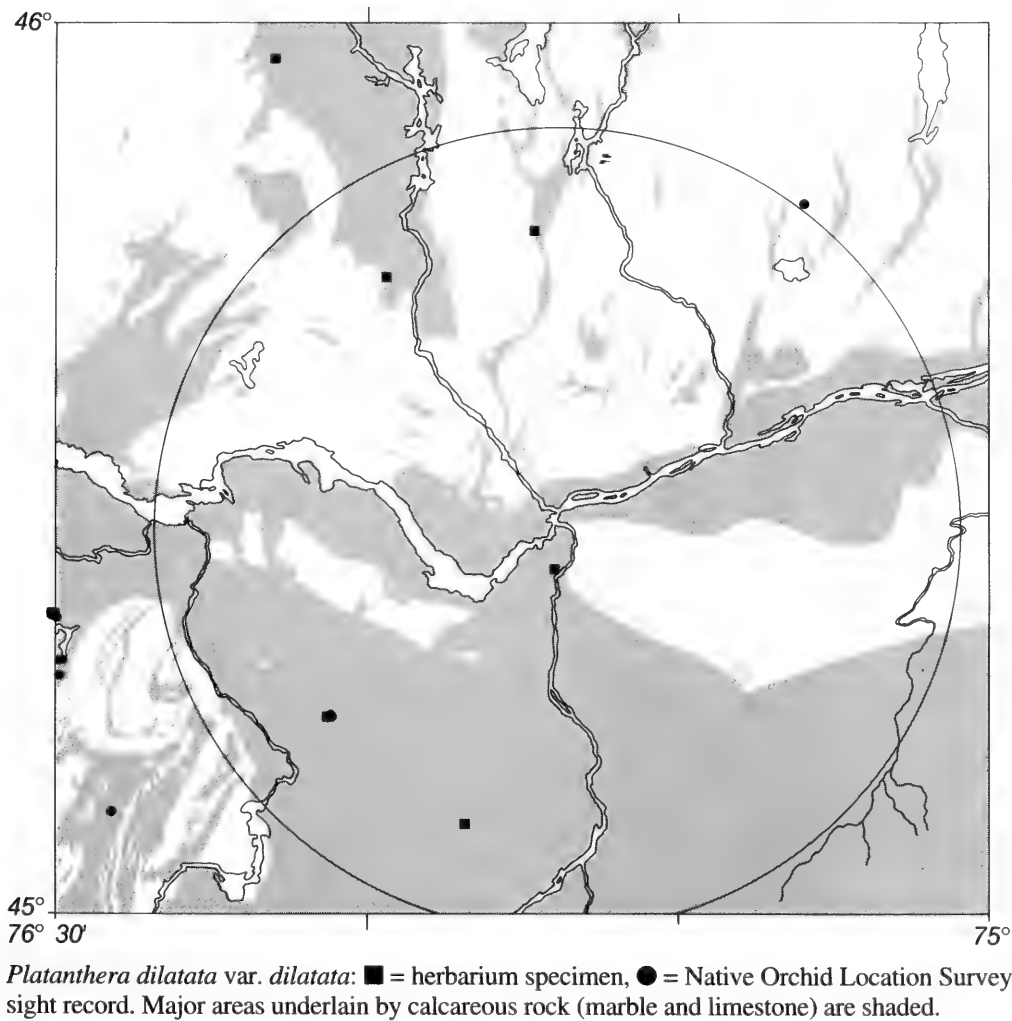




FIGURE 27. *Platanthera dilatata* var. *dilatata*, sedge fen habitat, Val-des-Monts Municipality (Wakefield Township, Gatineau County), Quebec, 1 July 1974.

HABITAT: *Platanthera dilatata* occurs only in open sedge fens and in a few adjacent treed fens. It never grows in the more acidic environments of bogs. In sedge fens, plants are scattered across the fen floor in full sun, accompanied here and there by *Pogonia ophioglossoides* and *Calopogon tuberosus*. It avoids the wettest parts of fens, that is, the centres of basin fens and the outer edges of floating fens. (Our photograph in Baird (1983) shows a plant of *P. dilatata* in typical sedge fen habitat near Poltimore, Quebec; see also Appendix 2.) There are sometimes suitable conditions for a few plants in sedgy openings among Eastern White Cedar, Black Spruce and Tamarack where the central open fen gives way to treed fen. Populations have been present in these fens for 30 years and likely have been there for a century or longer.

EARLY HISTORY: Braddish Billings Jr. made the first two Ottawa District collections at Dow's Swamp, less than 2 km west of the family home at Billings Bridge, on 9 July 1860 [QK 66646] and 8 July 1861 [CAN 227237]. He made a third collection in 1866 (Billings 1867), its current location unknown. These collections likely came from the floating sedge fen on the edge of the central pond shown in the 1925 air photo (Reddoch 1978b). He collected *Pogonia ophioglossoides* there on the same dates and *Calopogon tuberosus* there on the first date. James Fletcher collected *P. dilatata* at Dow's Swamp in 1878 [DAO 17071]. Collections in this century began fifty-four years later with Bill Dore's 1932 specimen from Glenfarne (= Danford Lake, Pontiac County), Quebec.

Platanthera flava (Linnaeus) Lindley var. *herbiola* (R. Brown) Luer

Northern Tubercled Orchid

Platanthère à gorge tuberculée var. petite-herbe

SYNONYMS: *Habenaria flava* (Linnaeus) R. Brown var. *herbiola* (R. Brown) Ames and Correll, *Habenaria virescens* Sprengel, *Platanthera flava* (Linnaeus) Lindley var. *herbiola* (R. Brown) Luer f. *lutea* (Boivin) Whiting and Catling

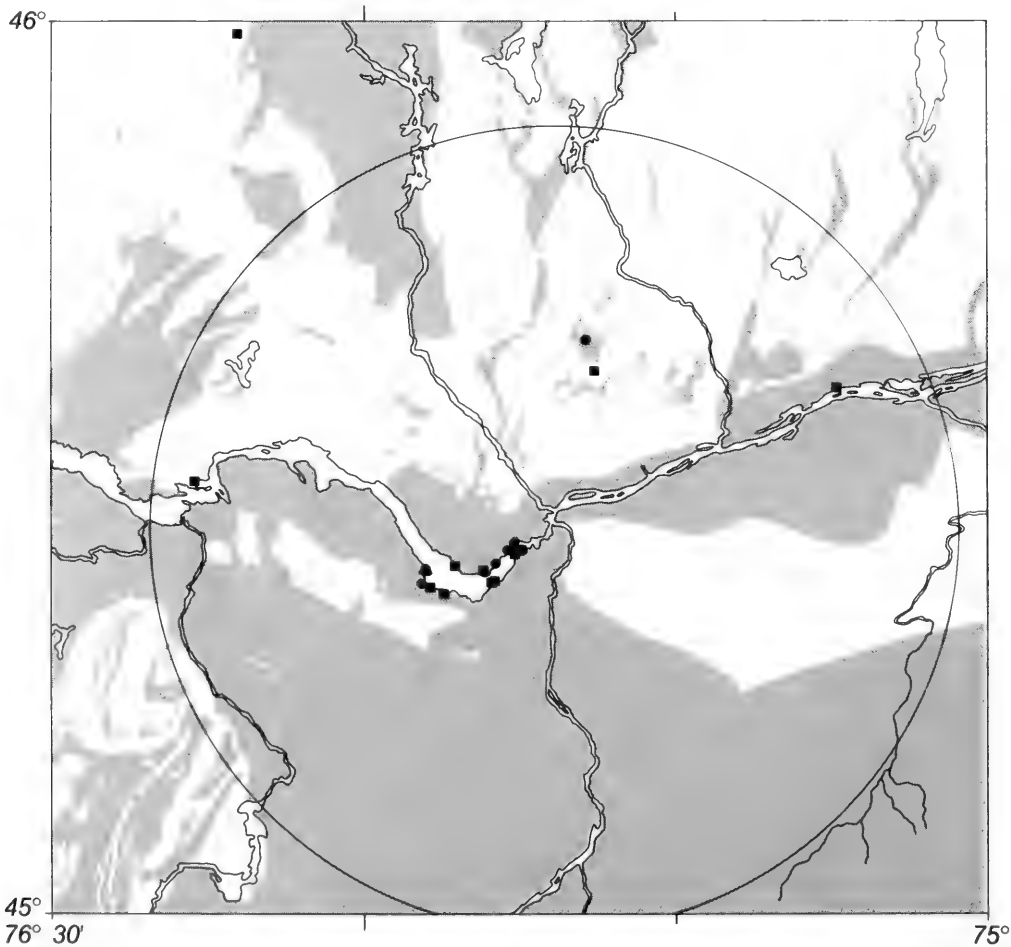
Platanthera flava is a rather rare orchid in the District, but, being green and inconspicuous and inhabiting wet, weedy or woody shores and flood plains, it may be somewhat overlooked. It is a plant with cauline leaves and a cylindrical inflorescence of yellowish green flowers with the spurs somewhat longer than the lips. However the most diagnostic feature of the flower is the mound or tubercle rising from the base of the lip. The tubercle is most clearly seen from the side.

DESCRIPTION

Height: 18 (24 - 35) 40 cm [52 plants].
Flowers: 13 (18 - 33) 50 [40 plants]; bicoloured with greyish green sepals and pale yellow, sometimes to pale green, petals, lip and spur; in a moderately dense cylindrical inflorescence of somewhat irregular appearance with flowers rotating in both directions on a single plant; fragrance moderately strong, sweet and very pleasant.
Leaves: 3, occasionally 4, with 2 or 3 cauline bracts; 2 on non-flowering plants.

Overwintering State: a shoot rising from a horizontal root several cm away from the current year's stem; herbarium specimens show the new shoot present at anthesis.
Capsules: brown, ellipsoid, typically 0.6 x 0.3 cm, ascending.
Seeds: dark brown, released in early to mid October.

BLOOMING PERIOD: 1 July (8 July - 1 August) 6 August [16 records].



Platanthera flava var. *herbiola*: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record. Major areas underlain by calcareous rock (marble and limestone) are shaded.



FIGURE 28. *Platanthera flava* var. *herbiola*, Ottawa River shore among shrubs, Britannia, City of Ottawa, Regional Municipality of Ottawa-Carleton, Ontario, 3 July 1975.

COLONY SIZES: 1 - 300 flowering and non-flowering plants [13 colonies], as scattered individuals and as patches of flowering and non-flowering stems.

CURRENT STATUS: rare in the Province of Quebec (Bouchard et al. 1983); rare to uncommon (S3) in Ontario (Watch List, Oldham 1996*); rare in the Ottawa District. Most of the colonies mapped no longer survive.

DISTRIBUTION: The Ottawa District is near the northern edge of the range of this eastern orchid of the Deciduous and Mixed Forest Regions. Within the District, most discoveries of *P. flava* have taken place on the north and south shores of the Ottawa River upstream from Ottawa, but some colonies have been found in a few other locations in Quebec. The Native Orchid Location Survey contains a record from the Mississippi River just south of the Study Area. Colonies generally occur in areas of calcareous bedrock.

HABITATS: Moist, open or partly shaded areas on the flood plains of the Ottawa River and some of its tributaries provide favourable habitats for this orchid. On these flood plains, several zones are occupied: open, grassy and weedy beaches not far above the summer water-line, shrub zone edges facing the water, clearings in willow thickets, and forest floors under Red Maple, Silver Maple (and their hybrids) and Red Ash. Soils are sandy or silty. Purple Loosestrife (*Lythrum salicaria*) is an almost constant companion in these four situations and may be a threat to the survival of these habitats. In more exposed locations, *Spiranthes lucida* occasionally shares the same habitat.

One 1947 collection [DAO 17093] from the Britannia area came, not from the river edge, but from "along the railway tracks" that ran parallel to the Ottawa River a short distance away. Here, the plants grew in "rich black loam". Colonies have been known on the river shore in the Britannia area for several decades.

EARLY HISTORY: The only collection that Macoun (*circa* 1911*) cited was one made by Robert B. Whyte in August 1879 in a "wet place, bank of river near Ottawa". Very few of Whyte's collections are held in public herbaria, and this is not one of them. James Fletcher (1880) did not have this species in his first *Flora Ottawaensis* but included it as an addition to the list a year later (sub *Habenaria virescens*, Spreng.; Fletcher 1881), perhaps on learning of Whyte's collection. Curiously, a decade later, James Fletcher, Robert B. Whyte and William Scott (1891) and Fletcher (1891) reported Scott's collec-

tion of *P. flava* at Thurso on 6 August 1890 [DAO 267279, TRT 15571] as a new species for the District. Fletcher described only this latter collection in his *Flora Ottawaensis* of 1893.

On 5 July 1906, W. Hague Harrington found *P. flava* "in some abundance" on the north shore of the Ottawa River "near the Country Club" [DAO 267281]. The habitat was "a marshy river-front" where the plants were dispersed among sedges and other plants. When he visited the colony the next year, he found it much reduced as a result of being "badly trampled by cattle which seek the river either to drink or stand in the water, and destroy much of the littoral vegetation" (Harrington 1917, [CAN 116954, 116955]).

COLOUR PATTERN VARIANT: Boivin typified f. *lutea* (Boivin) Whiting and Catling (Catling 1982a), an obscure name attributed to Louis-Marie. He chose for the type a 1966 collection of L. C. Sherk [547 at DAO] and E. W. Greenwood from the now extirpated colony at Remic Rapids, and described it as *floribus luteis*.

The collectors did not report the flower colour but Ed Greenwood has told us (personal communication 1996) that they chose the plant as representative of the colony. When we saw and photographed that colony in 1969, the flowers were generally bicoloured with greyish green sepals and pale yellow lips and petals. In 1996, the bicoloured character of the type was still evident in spite of some fading. The sepals were greyish green to the same degree as the leaves, while the petals and lips were light brown and showed no sign of green. This description applies to most of the *P. flava* of the District. Such bicoloured patterns are typical of a number of Ottawa District orchids.

A small sample of collections and published colour photographs from other parts of the range of *P. flava* var. *herbiola* suggests that such bicoloured flowers may be the norm. Some photographs (e.g., Luer 1975) do show yellowish green in the lips and petals of both var. *herbiola* and var. *flava*; however, Homoya (1993) reported green to be the flower colour of var. *herbiola* as distinguished from var. *flava*. These variations in lip and petal colour could be the result of explicit colour pattern variation or be within the normal range of control of chlorophyll formation.

These observations suggest to us that f. *lutea* may not differ from the type of var. *herbiola*. Although we have not seen the approximately 200 year-old type specimen, it may be, however, that the original colours have disappeared.

Platanthera grandiflora (Bigelow) Lindley

Large Purple Fringed-orchid

Platanthère grandiflore

SYNONYM: *Habenaria fimbriata* (Dryander) R. Brown

Platanthera grandiflora is one of our most spectacular orchids, being both large and colourful. It is similar to the more common *P. psycodes* (Stoutamire 1974) with which it sometimes grows. These two species can be easily recognized by their numerous purple fringed flowers on a leafy stem. *Platanthera grandiflora* is distinguished from *P. psycodes* by having a large round entrance to the spur rather than a somewhat flattened one and by having anther sacs that diverge downward instead of being close and parallel. The former species also tends to have flowers nearly twice as large as the latter.

DESCRIPTION

Height: 33 (44 - 73) 97 cm [71 plants].

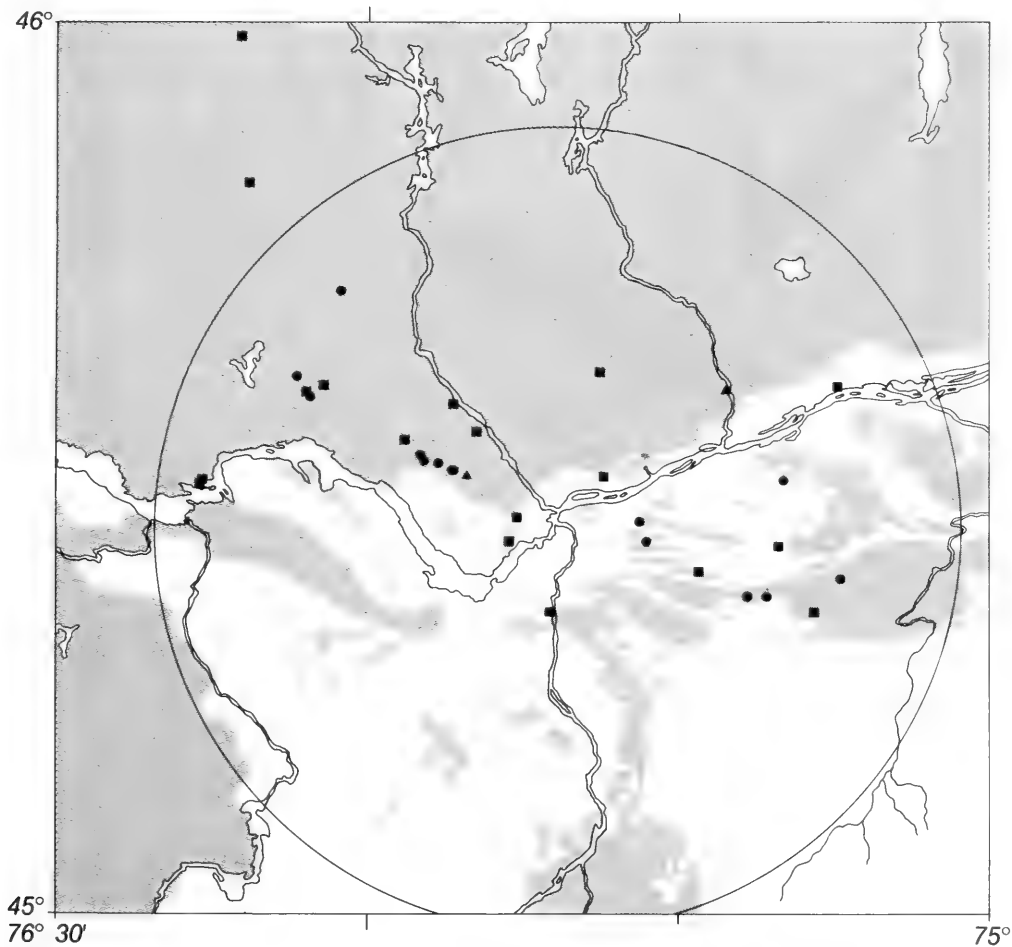
Flowers: 1 (12 - 34) 55 [87 plants], on average about three-quarters as many as on *P. psycodes*; generally light lilac, pale violet or purple, occasionally deep violet or so pale as to be almost indistinguishable from white (Petrie (1981) illustrates the latter colour on an Ottawa District plant), with white at base of lip and on column; spur translucent, often becoming pale violet sometimes with a trace of green toward tip; in a fairly dense, regular inflorescence; fragrance light, sweet, daisy-like.

Leaves: 3 - 5, with 2 - 5 bracts, 1 - 3 on non-flowering plants.

Overwintering State: a greyish green, broadly to narrowly conical shoot, 1 - 4 cm above ground beside the current year's stem, appearing there in late September; herbarium specimens show the new shoot and partially elongated roots present at anthesis.

Capsules: light brown, ellipsoid to oblong, typically 1.3 x 0.35 cm, ascending to erect (see Figure 1c); yield highly variable, averaging 50% [10 plants].

Seeds: dark brown, released in mid to late September.



Platanthera grandiflora: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record, ▲ = literature reference. Areas of major sand deposits on the Lowlands are shaded, as is the Canadian Shield.



FIGURE 29. *Platanthera grandiflora*, deciduous forest/stream flood plain habitat, Gatineau Park, Quebec, 3 July 1976 (plant), 15 July 1980 (flowers).

BLOOMING PERIOD: 16 June (27 June - 13 July) 23 July [55 records], of shorter duration and two to three weeks earlier than *P. psycodes*.

COLONY SIZES: 1 - 15, typically to 8, flowering plants [14 colonies] (sometimes to 50 flowering plants (Paul Catling, personal communication 1996)), as scattered individuals, rarely in clumps of several flowering and non-flowering stems.

CURRENT STATUS: rare in the Province of Ontario (Catling, Whiting et al. 1982), extremely rare (S1) in Ontario (Active List, Oldham 1996*).

DISTRIBUTION: The Ottawa District is at the north-western limit of the distribution of this Appalachian - Atlantic Coast species of the Mixed Forest Region (Stoutamire 1974). It has not been found farther up the Ottawa Valley (Runtz 1984, personal communication 1996; Whiting and Catling 1986). Within the District, this orchid is scattered across the Canadian Shield, generally in areas of acidic bedrock or deep sand. On the Lowlands, it is localized on the sands deposited by the Champlain Sea and subsequent rivers.

HABITATS: The most common places for *P. grandiflora* on the Canadian Shield are moist to wet depressions, stream edges and flood plains under the high canopies of deciduous forests, usually with Sugar Maple and Beech dominating.

The leaf-carpeted sandy loam or muck is often completely saturated and sometimes plants are standing in shallow water. Companion species include Lady Fern (*Athyrium filix-femina*), Ostrich Fern (*Matteucia struthiopteris*), Sensitive Fern (*Onoclea sensibilis*), Stinging Nettle (*Urtica dioica*) and Touch-me-not (*Impatiens capensis*), as well as *Platanthera psycodes*.

On the Lowlands, *P. grandiflora* usually grows in the dappled shade of poorly-drained Red Maple forests. One site that was more mesic than usual was a shaded, second growth forest of White Pine, Sugar Maple, Largetooth Aspen and other trees. The sandy substrates in forests on the Lowlands are moist to wet owing to the relatively impervious layer of clay underneath but are susceptible to drying out during periods of drought.

Both on the Shield and in the Lowlands, colonies are found only rarely in the open, moist, sedgy patches that are a common habitat for *P. psycodes*.

LONG-LIVED COLONIES: The mixed colony of *P. grandiflora* and *P. psycodes* in Gatineau Park that we discovered in 1969 (Reddoch 1976; J. M. Reddoch and A. H. Reddoch 1987a) continues to thrive. Numbers, never large, vary from year to year as plants appear, flower for a few years and then disappear. The habitat is a wide stream valley that is kept saturated by steady seepage from a beaver pond upstream. The formerly closed canopy of Sugar Maple, Beech, White Elm, White Birch and Yellow

Birch is now more open with the demise and decomposition of the large elms. White-tailed Deer are a menace in this colony because they eat off the tops of flowering plants and occasionally trample shoots.

The mixed colony that Ed Greenwood recorded in 1968 on the Lowlands in Cumberland Township (J. M. Reddoch and A. H. Reddoch 1987a) survives with only *P. grandiflora* remaining. The *P. psycodes* plants in the shallow roadside ditch disappeared a couple of years after we saw them, apparently the victim of spraying; however, a few *P. grandiflora* continue to appear in the ditch from time to time. They occur as well in the adjacent, young Red Maple - Trembling Aspen - Yellow Birch forest. The forest colony may serve as a seed source for restocking the ditch after spraying, or more recently, cutting. Both habitats are moist to wet with substrates of silty humus and sandy clay. Sensitive Fern, Cinnamon Fern (*Osmunda cinnamomea*) and Marsh Fern (*Thelypteris palustris*) accompany the orchids at this site, along with many roadside weeds in the ditch.

Mixed colonies of *P. grandiflora* and *P. psycodes* are known at a few other places in Gatineau Park and on the floodplain of the Picanoc River at the northern edge of the Study Area (Reddoch 1976).

EARLY HISTORY: James Fletcher added this species to his 1880 *Flora Ottawaensis* in 1881, probably on the basis of Henry M. Ami's specimen collected in 1880 in the "Laurentian Hills, Blanche River, East Templeton, P.Q." [DAO 84103]. Although only the top half has been preserved, it is enough to show that the plant was exceptionally robust. By 1893 (Fletcher 1893), this orchid had been found at two other sites, Eastman's Springs (Macoun, Whyte, and Fletcher 1884) and Kingsmere. It was collected at Eastman's Springs (= Carlsbad Springs) also in 1887 and 1908 ([TRT 15561, DAO 84105], Gibson 1908). Both Fletcher (1893, 1896) and W. Hague Harrington (1917) concluded that the species was rare in the District.

Harrington (1917) made collections on the edge of the railway ditch near Kirk's Ferry in 1906 and near Chelsea in 1906 and 1907 [CAN 116949 - 116952]. The best locality known to him was "a small area of springy ground near a cedar swamp in the deep woods north of Chelsea, but this habitat will probably have been destroyed by the fires which followed the cutting down of the beautiful forest. Instead of grateful shade and lovely woodland vistas, there are left the crumbing rocks denuded of soil and desolate with the blackened trunks and stumps of the forest monarchs".

ACYANIC FORM: Two herbarium collections from the Ottawa District may be referable to the white-flowered f. *albiflora* (Rand and Redfield) Catling. One of Harrington's 1906 collections from Chelsea [CAN 116951] includes one plant labelled "albino". This identification is credible but cannot be verified,

given the present brown colour of the specimen. A 1943 collection by Gaston Lamarre from Thurso [DAO 84111] was annotated "*Habenaria psycodes* var. *grandiflora* f. *leucophaeopsis*" by B. Boivin in 1966, although the collector did not describe the flower colour. The specimen currently is uniformly brown with no anthocyanin evident. If the plant had initially had only a small amount of pigment, this could have faded in the intervening 23 years before Boivin examined it.

The palest flowers that we have seen, on a plant in

the long-lived Gatineau Park colony discussed above, could easily have been described as albino. However, the presence of anthocyanins was confirmed by a clear boundary between the white base of the lip and the faint violet white of the rest of the lip. If a complete absence of anthocyanin, that is, a genetic mutation preventing its formation, is required in the definition of f. *albiflora*, then this plant does not qualify. Similarly, the 1943 collection discussed above could also have had pale, rather than pure white, flowers.

Platanthera hookeri (Torrey) Lindley

Hooker’s Orchid

Platanthère de Hooker

SYNONYM: *Habenaria hookeri* Torrey

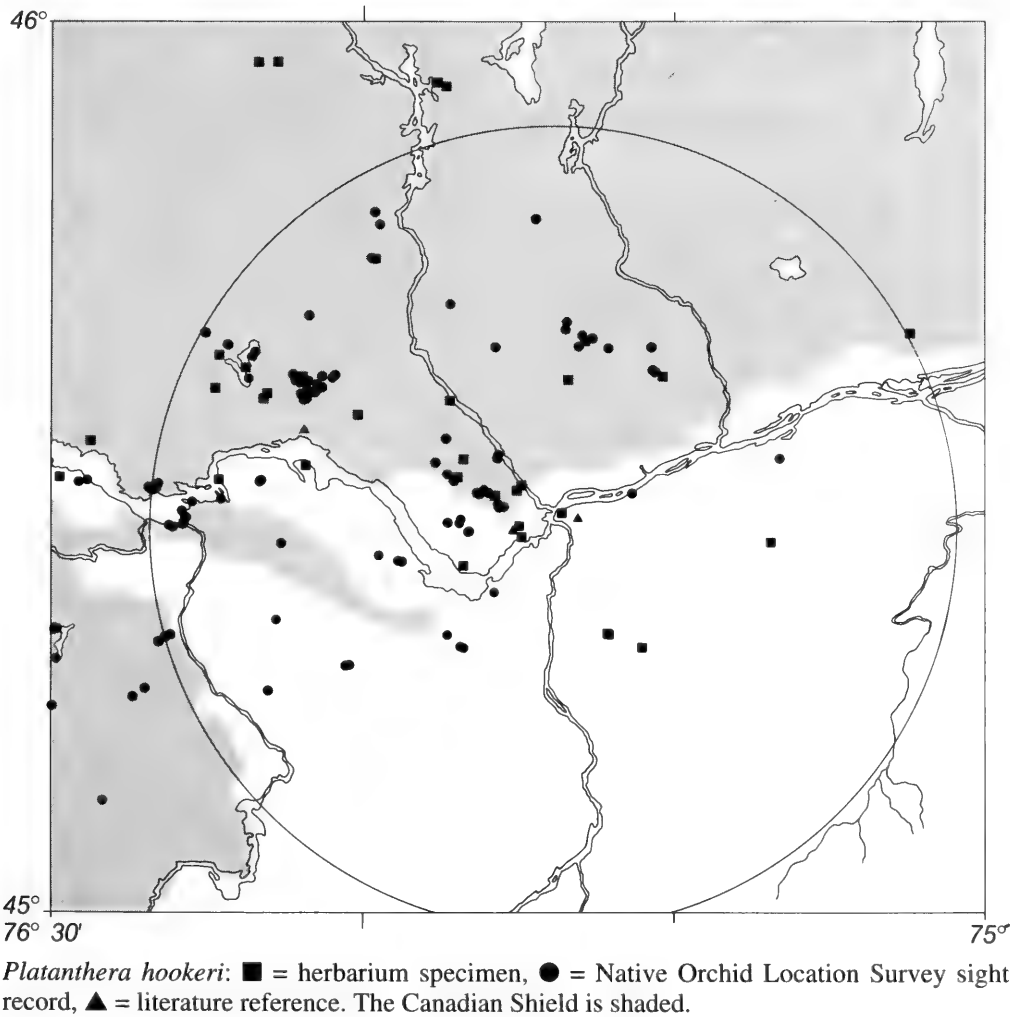
Platanthera hookeri is widely but thinly distributed in the forests of the District. Although it is one of the green orchids, its spiky, open inflorescence is often conspicuous above the bare forest floor. Like *P. orbiculata* and *P. macrophylla*, it has two conspicuous, round, basal leaves. It can be distinguished from these two species by its flowers, which are green or yellowish green instead of whitish. Its spurs taper to points and its lips are upturned. In addition, with rare exceptions, *P. hookeri* lacks cauline bracts.

DESCRIPTION

- Height:** 14 (22 - 33) 44 cm [129 plants].
- Flowers:** 2 (8 - 16) 25 [138 plants]; sepals deep green, petals, lip and spur greyish green or yellowish green sometimes tending to greenish yellow; fragrance light, floral, by day.
- Leaves:** 2, basal; 1 - 2 on non-flowering plants; either ascending or lying on the ground at anthesis, plants apparently maintaining the same orientation from year to year; dull to slightly lustrous; rarely 1 cauline bract, seen twice in the small colony at Mud Pond (see below) but nowhere else in the District.
- Overwintering State:** a greyish green, broadly conical shoot, 1 - 2 cm above ground beside the cur-

rent year’s stem, appearing there in late September; herbarium specimens show the new shoot and partially elongated root usually present at anthesis.

Capsules: greyish orange, brownish orange or dark brown, ellipsoid to obovoid, typically 1.4 x 0.5 cm, erect; yield usually less than 60%, averaging 30% [30 plants]; pollinators not known (Catling and Catling 1991) and often not very effective, especially in the Gatineau Park colony that we have monitored (see below); on two occasions we have found similar lepidopteran bristles and scales on the stigmatic surfaces of flowers at different sites. In one of the flowers, both hemipollinaria had been removed; in the other, neither had been disturbed but there was



pollen on the stigmatic surface. These observations together with the flower colour suggest that the pollinators are moths.

Seeds: brownish orange to brown, released in early to mid October.

BLOOMING PERIOD: 8 May (1 June - 29 June) 16 July [67 records].

COLONY SIZES: 1 - 143, typically to 45, flowering and non-flowering plants; 3 or fewer in 50% of colonies [126 colonies], generally as scattered individuals.

DISTRIBUTION: The Ottawa District is near the northern limit of the range of this Mixed Forest Region species. Within the District, *P. hookeri* is almost completely confined to the Canadian Shield and some adjacent Lowland areas.

HABITATS: This woodland species is most often found in the medium shade of moist, fairly mature, Sugar Maple - Beech, Sugar Maple - Eastern Hemlock, Eastern White Pine and Eastern White Cedar forests. It is also found in forests just above the edges of swamps or other wet areas. Occasional plants are encountered in pine plantations and in partially shaded Trembling Aspen and other young deciduous or mixed woods.

Generally, *P. hookeri* grows where there is little other vegetation. Soils are shallow to deep sands, sandy loams or gravels over many bedrock types. *Cypripedium acaule* is sometimes a companion in coniferous forests on sand.

Rarely, a few plants grow in the moist humus of calcareous peatlands.

LONG-LIVED COLONIES: *Platanthera hookeri* is a long-lived plant and colonies can thrive for many years in undisturbed surroundings. The patterns of development that colonies follow are fairly individual and may depend on conditions related to their specific habitats.

In 1984 we began to monitor a well-established colony of *P. hookeri* near Kingsmere in Gatineau Park that we had known since 1978. The plants are scattered across an area about 30 m x 15 m under a fairly dense canopy of Sugar Maple with some Eastern Hemlock, Eastern White Pine and Hop Hornbeam. Young hemlocks form the understory and many of the plants are under the edges of the hemlock boughs. The sandy loam is heavily covered with deciduous leaf litter and fairly devoid of other vegetation, except for a few patches of Wild Lily-of-the-valley (*Maianthemum canadense*). The underlying bedrock is granite pegmatite (Hogarth 1970).

A total of 22 plants has been followed between 1984 and 1996. Nine plants have been present for the whole 13 years and all of these have flowered at least once. Three additional plants that were present in 1984 have disappeared. Ten new plants have been found during the course of this study, three of which

have since disappeared, one after only one year. (Some of the plants that have disappeared may have been smothered by the heavy annual blanket of fallen tree leaves; in June we have had to lift off the matted leaves to locate a number of plants over the years.)

Of the 22 plants, 14 have flowered at least once. Of these, 4 flowered once, 4 twice, 1 three times, 1 four times, 2 five times, and 1 each seven and eight times. The plant blooming most frequently flowered 7 years out of 8 with a break in the 6th year and then flowered again (in 1995) after a break of 3 years. (It also had flowered in 1981.) It did not set seed in any of the years that it flowered.

In 1991, we found two additional plants near the original colony. Between 1991 and 1996, one has flowered four times and the other twice.

For all 24 plants, the average percentage of plants flowering per year between 1984 and 1996 is 24%, with a range from 0% to 55%. There were four years when the average was between 0% and 7%, and four other years when it was 46% to 55%. The relatively high frequency of years with few flowers or with a comparatively large number of flowers is inconsistent with a model of independent random flowering, as can be shown with a chi-squared analysis. Evidently there is a tendency to coordinated flowering, possibly the result of annual climatic influences, although other factors may be involved as well.

Capsule production in the colony as a whole has been very small. Eighty-three percent of the flowering plants examined since 1981 did not produce capsules. In the exceptional year of 1981, six of eight flowering plants produced capsules with a yield per inflorescence of 17% to 57%.

Most of this colony consisted of two-leaved plants from the first time they were recorded. Only two plants declined to one leaf for a couple of years before disappearing.

Recently we began to monitor another colony of *P. hookeri* in Gatineau Park, this one near Black Lake. It is in a relatively open, moist, mostly deciduous forest of Sugar Maple, Red Oak, Beech and Eastern Hemlock over calc gneiss bedrock. Ground cover is dominantly Wood-betony (*Pedicularis canadensis*). After only three years, we can see that this colony presents a somewhat different picture of flowering frequency and capsule production than the colony described above. All seven plants have flowered each year and the capsule yield ranges from 5% to 95% with an average of 40%.

Across the Ottawa River in Ottawa-Carleton, Ed Greenwood discovered a colony of *P. hookeri* near Mud Pond in 1962. (The plant in the Figure was a member of this colony.) The plants were growing in dappled shade at the edge of a cedar swamp. We followed this colony of up to six plants from 1967 to 1977. During this time, one of the plants flowered for six consecutive years and another flowered for five consecutive years. None of the other plants



FIGURE 30. *Platanthera hookeri*, plant: cedar swamp habitat near Mud Pond, City of Kanata, Regional Municipality of Ottawa-Carleton, Ontario, 14 June 1969; flowers: mixed forest habitat, Gatineau Park, Quebec, 6 June 1978.

flowered during that period. In 1977, we found that the colony had been flooded out by rising water levels; it did not appear again.

EARLY HISTORY: *Platanthera hookeri* was one of the 1867 additions to Braddish Billings Jr.'s (1867) list of plants collected in 1866. In 1878, James Fletcher collected the species in various rich and rocky woods in the "Chelsea Mountains" and at "Hull", Quebec [MTMG 48465, DAO 267282,

267285] at the beginning of concerted botanical exploration north of the Ottawa River. Ottawa Field-Naturalists' Club excursions to Gilmour's Grove, near Chelsea, Quebec, in 1904 and 1908 found *P. hookeri* along with *Cypripedium acaule* and *Galearis spectabilis* (Clarke 1904, 1908). Gilmour's Grove consisted of a stand of ancient Eastern White Pines, a hemlock grove and numerous deciduous trees (Reddoch 1979b).

Platanthera huronensis (Nuttall) Lindley

Fragrant Green Orchid

Platanthère de la Huronie

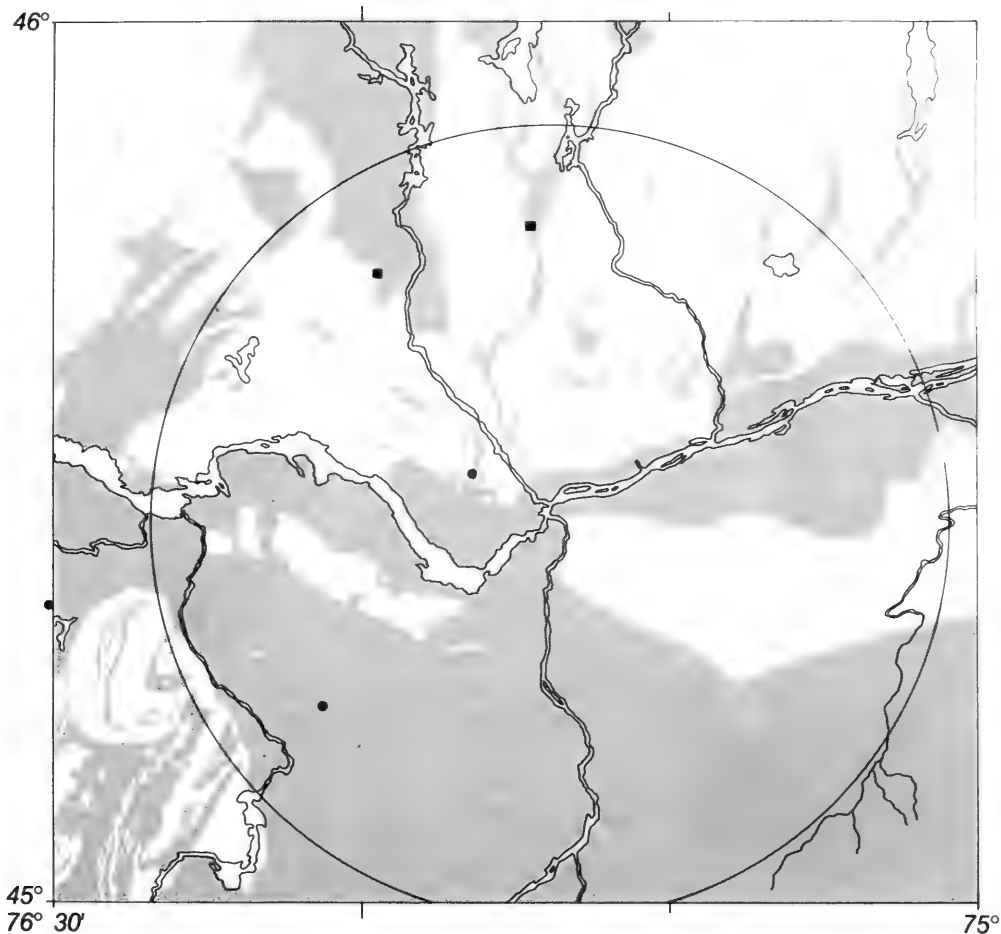
SYNONYMS: *Platanthera hyperborea* (Linnaeus) Lindley var. *huronensis* (Nuttall) Luer, *Platanthera* x *media* (Rydberg) Luer, *Habenaria hyperborea* (Linnaeus) R. Brown var. *huronensis* (Nuttall) Farwell

The taxon referred to here as *Platanthera huronensis* has been considered by Luer (1975) and others to be a putative hybrid between *P. hyperborea* and *P. dilatata*. Schrenk (1978) suggested that the hybrid may be, in fact, a hybridogenic new species. Plants referable to *P. huronensis* as described by Charles Sheviak (personal communication 1996) occur in several Ottawa District fens, and it is these plants that we describe below. Both *P. huronensis* and *P. hyperborea* can be distinguished from our other *Platantheras* by their several cauline leaves and numerous small, greenish flowers (not pure white as in *P. dilatata*) with entire lips comparable in size to the spurs. In the Ottawa District, *P. huronensis* can be distinguished from *P. hyperborea* by its open sedge fen habitat (rarely in swamps), and its larger, light green flowers with a distinct rose-like fragrance. The two species can also be separated by differences in the orientations of the anther sacs in the column (Paul Catling, personal communication 1994). See Further Diagnostic Notes below and the *P. hyperborea* account following.

DESCRIPTION

Height: 27 (39 - 70) 91 cm [56 plants].
Flowers: 12 - 105 [24 plants]; light green (but not white) in the field; under the microscope, colours darker but not as dark as *P. hyperborea*; dorsal sepals green or yellowish green with some readings of light green or greyish green, lip, spur and petals greyish green, usually lighter than the sepals, edges of petals white; (lighter measurements in the field

may be the result of surface light-scattering effects); arranged in moderately dense to dense inflorescences; fragrance rose-like.
Leaves: 4 - 11 leaves and bracts [23 plants]; 1 - 4 leaves on non-flowering plants.
Overwintering State: a greyish green, conical shoot within the moss substrate at the base of the current year's stem, in late September.
Capsules: light brown to brown, oblong, typically



Platanthera huronensis: ■ = herbarium specimen, ● = our sight record and photographs. Major areas underlain by calcareous rock (marble and limestone) are shaded.

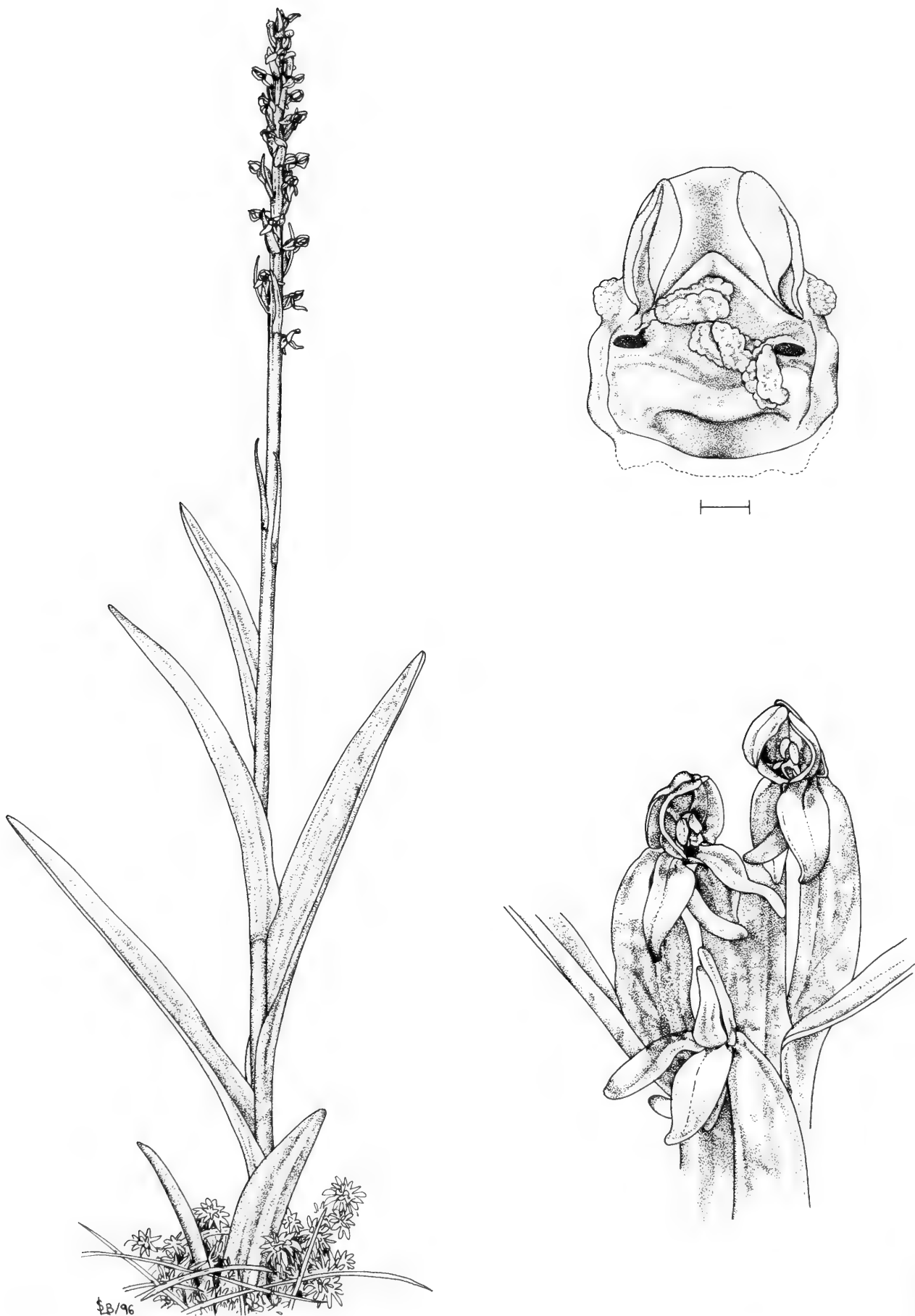


FIGURE 31. *Platanthera huronensis*, plant and column: sedge fen, Val-des-Monts Municipality (Wakefield Township, Gatineau County), Quebec, 28 June 1996; flowers: cedar - ash swamp, Gatineau Park, Quebec, 6 July 1969; for the column (front view showing self-pollination), scale bar = 0.5 mm.

1.0 x 0.4 cm to 1.5 x 0.6 cm, nearly erect (see Figure 1c); yield 90% - 100% [8 plants].

Seeds: light brown to brown, released in early September to early October, several weeks earlier than *P. hyperborea*.

BLOOMING PERIOD: 9 June (20 June - 14 July) 23 July and 14 August [16 records].

COLONY SIZES: 2 - 13 flowering plants [8 records]; as scattered individuals, sometimes in small clumps.

CURRENT STATUS: Our experience suggests that this species may be rare in the Ottawa District.

DISTRIBUTION: The Ottawa District is apparently well within the range of this transcontinental species of the Montane, Boreal and Mixed Forest Regions (Schrenk 1978; Charles Sheviak, personal communication 1996). Within the District, this orchid is apparently restricted to calcareous wetlands.

Since 1968 we have identified and photographed four colonies of the taxon currently recognized as *P. huronensis*, three in fens and one in a calcareous swamp. These are the colonies plotted on the distribution map along with a 1911 herbarium collection. A small number of additional swamp colonies of *P. huronensis* may have been recorded as *P. hyperborea* in the Native Orchid Location Survey and mapped as such; however, the vast majority of swamp colonies are of *P. hyperborea*. The general distribution pattern shown for the abundant *P. hyperborea* would not be significantly altered by the inclusion of a few colonies of *P. huronensis*.

HABITATS: *Platanthera huronensis* is known to us so far only from open sedge fens and clearings in adjacent treed fens as well as in an Eastern White Cedar - Black Ash swamp. In fens, the plants occur in the open but close to the margins. They are not as far away from the edges as *P. dilatata*, which invariably grows nearby. *Platanthera hyperborea* is usually present elsewhere in the wetland complex, generally in the swamp component.

LONG-LIVED COLONY: Since 1968 we have followed the colony in the sedge fen near Poltimore and it is from this colony that most of our knowledge about this orchid comes. Although the colony has persisted for many decades (and possibly centuries), individual plants do not appear to last longer than two or three years.

LOCAL HISTORY: We have seen only one herbarium specimen that is referable to *P. huronensis*. It was collected by Faith Fyles in June 1911 from "Northwakefield, P.Q. Swamp" [Fyles 2243 at DAO]. North Wakefield, present-day Alcove, was the location often given by Fyles and other botanists for Chilcott's Swamp, the calcareous peatland at the edge of Johnston Lake (Fyles 1912). Both *P. dilatata* and *P. hyperborea* were collected from the same peatland in the 1940s [DAO]. In 1979, we collected a specimen of *P. huronensis* from the sedge fen near Poltimore, Quebec [DAO 691524].

FURTHER DIAGNOSTIC NOTES: We provide below a comparative list of characters observed for plants referable to *P. huronensis* and *P. hyperborea*. Note that these results are restricted to the Ottawa District and the sample of *P. huronensis* is rather small, no more than 10 measurements of floral parts.

In our local populations, the flowers are at the small end of the range described by Sheviak and they differ from populations observed elsewhere (Sheviak, personal communication 1996) by being self-pollinating. We deduce that the flowers are self-pollinating because the hemipollinaria rotate forward and bring the pollinia into contact with the stigmatic surface (see Figure 31), where the pollen loses its colour. This action can be seen when the lip is up or down. We have done no experiments to exclude pollinators, and it may be that both external pollination and self-pollination takes place. The high capsule yields reported above also suggest self-pollination.

	<i>P. huronensis</i>	<i>P. hyperborea</i>
Habit:	semi-stout to stout	slender to stout
Height:	to 91 cm	to 87 cm
Leaves:	usually ascending	usually arcuate-spreading
Flowers:	pale green	yellowish, greyish or deep green
	fragrant	no odour
sepals:	spreading to somewhat reflexed	reflexed
lip:	moderately or slightly dilated	lanceolate or slightly dilated
length:	5.0 - 6.2 mm	3.5 - 5.5 mm
width:	2.0 - 2.5 mm	0.6 - 1.5 mm
spur length:	5.5 - 7.0 mm	2.7 - 5.0 mm
anther sacs:	separated at top,	touching at top,
	diverging slightly ($\pm 30^\circ$) downward	diverging widely ($\pm 90^\circ$) downward
viscidia:	elliptic	orbicular
viscidium spacing:	± 2.5 mm	± 1.1 mm
rostellum:	moderately arched ($90^\circ - 120^\circ$)	slightly arched ($\pm 150^\circ$)
self-pollinating:	yes	yes

Platanthera hyperborea (Linnaeus) Lindley var. *hyperborea*

Northern Green Orchid

Platanthère hyperboréal

SYNONYM: *Habenaria hyperborea* (Linnaeus) R. Brown

Platanthera hyperborea is widely distributed in the District, where it is notable for the variation in its habit and habitat. Both *P. hyperborea* and *P. huronensis* can be distinguished from our other *Platantheras* by their several cauline leaves and numerous small, greenish flowers (not pure white as in *P. dilatata*) with entire lips comparable in size to the spurs. *Platanthera hyperborea* can be distinguished from *P. huronensis* by its smaller, darker green flowers without fragrance. (See the preceding account of *P. huronensis* for additional details, including the column structure.)

DESCRIPTION

Height: 6 (16 - 47) 87 cm [204 plants].

Flowers: 2 (4 - 23) 60 [131 plants]; sepals green or yellowish green, occasionally greyish green or deep green, lip, spur and petals yellowish green to greyish green, usually lighter and yellower than the sepals; arranged in dense to lax inflorescences, occasionally in 3 or 4 spiral ranks; no detectable odour.

Leaves: 2 - 8, grading to an additional 1 - 3 bracts; 1 - 4 on non-flowering plants.

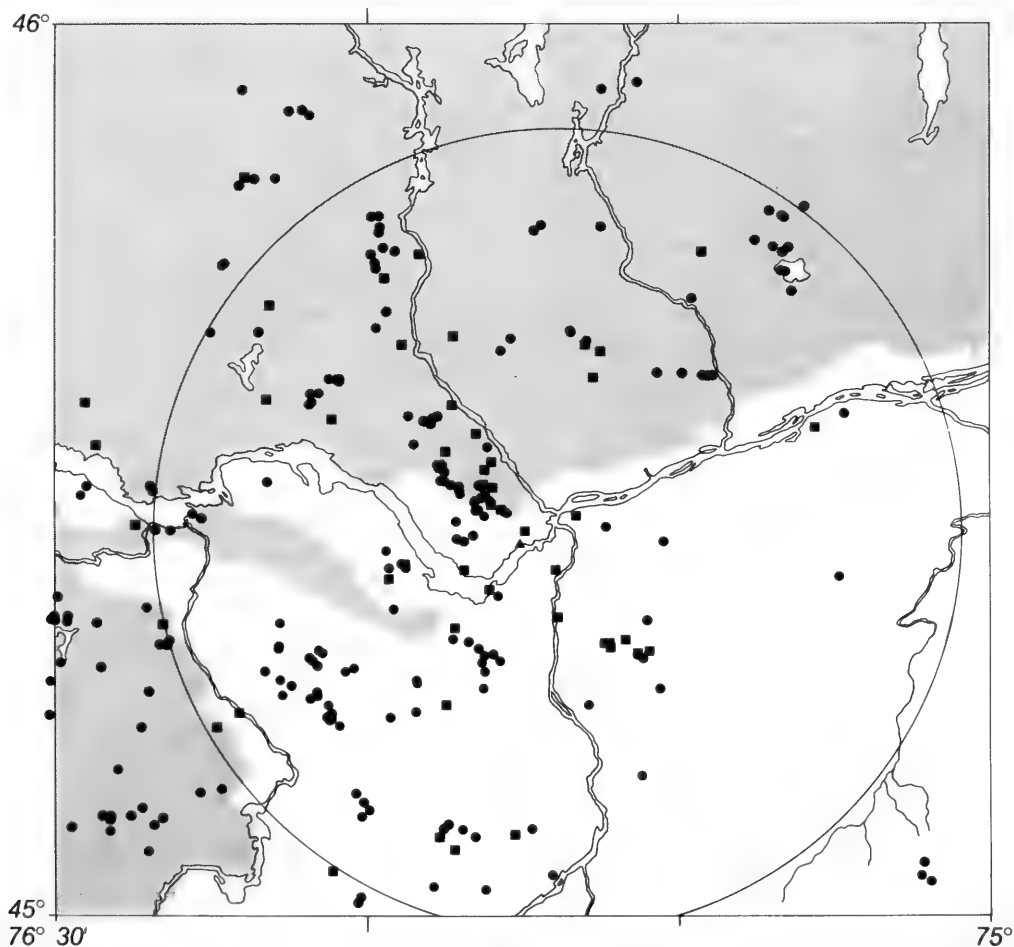
Overwintering State: a greenish white or greyish green, conical shoot, appearing at ground level beside the current year's stem, in October.

Capsules: brown to dark brown, oblong, typically 0.8 x 0.3 cm on small plants to 1.6 x 0.6 on large ones, nearly erect; yield usually greater than 50%, half of the plants approaching 100%, averaging 80% [58 plants].

Seeds: light brown to dark brown, released in late October (rarely September).

BLOOMING PERIOD: 14 June (24 June - 16 July) 15 August [85 records].

COLONY SIZES: 1 - 690, typically to 140, flowering and non-flowering plants [204 colonies], mostly as individuals, but also in twos and threes.



Platanthera hyperborea var. *hyperborea*: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record, ▲ = literature reference. The Canadian Shield is shaded.

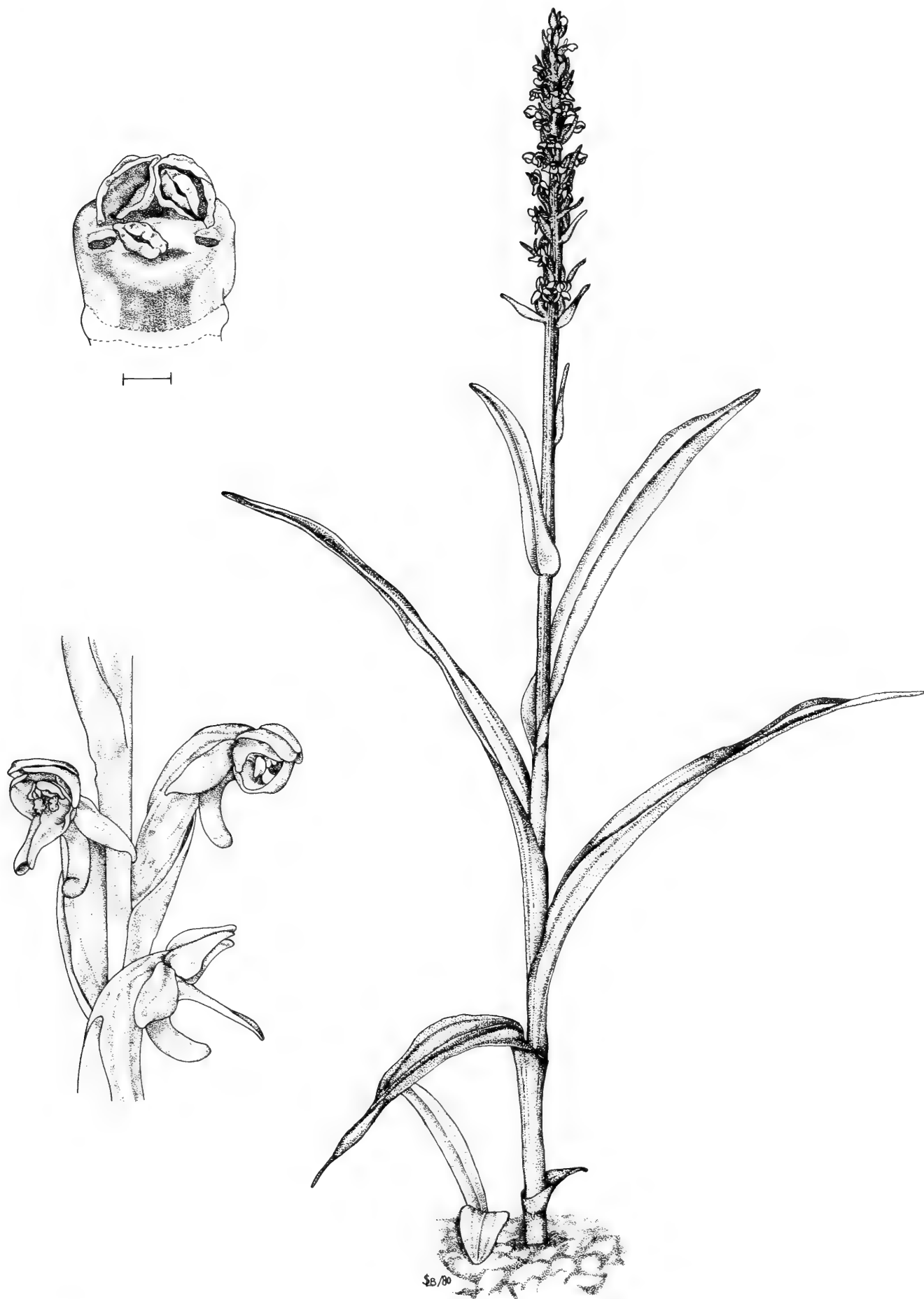


FIGURE 32. *Platanthera hyperborea* var. *hyperborea*, plant: swamp habitat, Gatineau Park, Quebec, 5 July 1980; flowers and column: mesic, mixed forest, Gatineau Park, Quebec, 17 July 1996; for the column (front view showing self-pollination), scale bar = 0.5 mm.

CURRENT STATUS: one of the most abundant and widespread orchids in the District.

DISTRIBUTION: The Ottawa District is well within the range of this transcontinental species of the Boreal, Montane and Mixed Forest Regions. This orchid is distributed throughout much of the District especially in areas of calcareous bedrock.

HABITATS: *Platanthera hyperborea* thrives in somewhat shaded, moist to wet places such as swamps, low-lying woods, seeps and stream edges. Colonies are also found in moist deciduous forests and cedar woods. This orchid grows in both mineral and organic soils over a variety of bedrock types. It does not grow in bogs.

Almost any type of swamp provides suitable habitat for *P. hyperborea*, from Eastern White Cedar - Black Ash swamps to mature Eastern White Cedar swamps with widely-spaced, large trees. Ground cover may be abundant, or almost absent; plants are rooted in mosses or organic soils.

Plants also grow in running water around springs, in the rich muck of seasonal stream beds and at the edges of streams and ponds. Usually these places are at least partially shaded, but occasionally colonies occur in the open in wet spots in meadows, gravel pits and old-fields.

Mesic to dryish cedar woods and fairly mature deciduous forests provide other habitats for this orchid. Plants come up through moist leaf mould under more or less closed canopies of Eastern White Cedar or of Beech, Sugar Maple, Largetooth Aspen and other trees. Ground cover is usually sparse.

Sandy road or track edges through swamps or forests sometimes support a few plants.

EARLY HISTORY: John Kerr McMorine’s two 1862 collections from Ramsay, Ontario, [QK 13017, 66657] are the earliest from the Ottawa District. *P. hyperborea* was included in Braddish Billings Jr.’s (1867) list of species that he collected in 1866, but specimens supporting this list have not been located. If the plant came from the fen at Dow’s Swamp (Reddoch 1978b), it could have been referable to *P. huronensis*. Henry M. Ami collected *P. hyperborea* in “MacKay’s Grove” in July 1879 [CAN 23407]. (MacKay’s Grove was likely on the MacKay Estate,

the property that extended across the centre of what is now the Village of Rockcliffe Park, Ontario (Belden 1879).) Across the Ottawa River in Quebec, the east bank of Beaver Meadow, the outflow valley of Fairy Lake west of Hull, was considered “a splendid locality” for this orchid (Eifrig 1909).

MORPHOLOGICAL VARIATION: *Platanthera hyperborea* is the most variable species in the District; for example, the ratio of standard deviation to average height is 0.5, appreciably greater than the ratios of 0.16 to 0.37 for the other species. This variation correlates with habitat. Plants growing in mesic forests have a restricted range of habit partly overlapping the broader range of wetland plants. On average, mesic forest plants are shorter, have fewer leaves and flowers, and have somewhat shorter and more lax inflorescences. They are generally slender, while plants of wet habitats range from slender to stout. The averages given below all differ between the habitats at a statistically very significant level. The blooming periods of the two groups are very similar.

ACHLOROPHYLLOUS FORM: The form *P. hyperborea* (Linnaeus) Lindley var. *hyperborea* f. *alba* Light was described in Light and MacConaill (1989) from plants in Gatineau Park. In addition to these plants, they also reported striped plants with green pigmentation in part. Some of the achlorophyllous plants flowered for at least two consecutive years.

On a subsequent visit to the site, we found some of the achlorophyllous plants to be pale yellow in the Methuen terminology (Kornerup and Wanscher 1978). The yellow colour, suggesting residual carotenoid pigments, was visible in the absence of chlorophyll. The plants were of the mesic forest habit and were fairly small, although not much smaller than chlorophyllous plants in the same colony.

Marilyn Light (personal communication 1996) has been aware of achlorophyllous plants in this colony for at least a decade. She has found individual plants to be short-lived. She observed that whereas chloroplasts in the normal green leaves stained positively for starch with iodine, those same structures in f. *alba* did not. This observation provides an independent demonstration of the absence of photosynthetic activity, consistent with the lack of chlorophyll, in f. *alba*.

Morphological Variation with Habitat

average (range) [sample size]	Mesic Forest Habitats	Wet Habitats
Habit	slender	slender to stout
Height	23 (6 - 47) cm [115]	41 (20 - 87) cm [59]
Inflorescence Height	6 (2 - 12) cm [64]	9 (3 - 19) cm [31]
Number of Leaves	3 (1 - 7) [89]	7 (4 - 13) [43]
Number of Flowers	10 (2 - 30) [87]	21 (5 - 60) [39]
Number of Flowers / cm	1.3 (0.5 - 3.6) [61]	2 (1.1 - 5) [29]

Platanthera lacera (Michaux) G. Don in Sweet var. *lacera*

Ragged Fringed-orchid

Platanthère lacéré

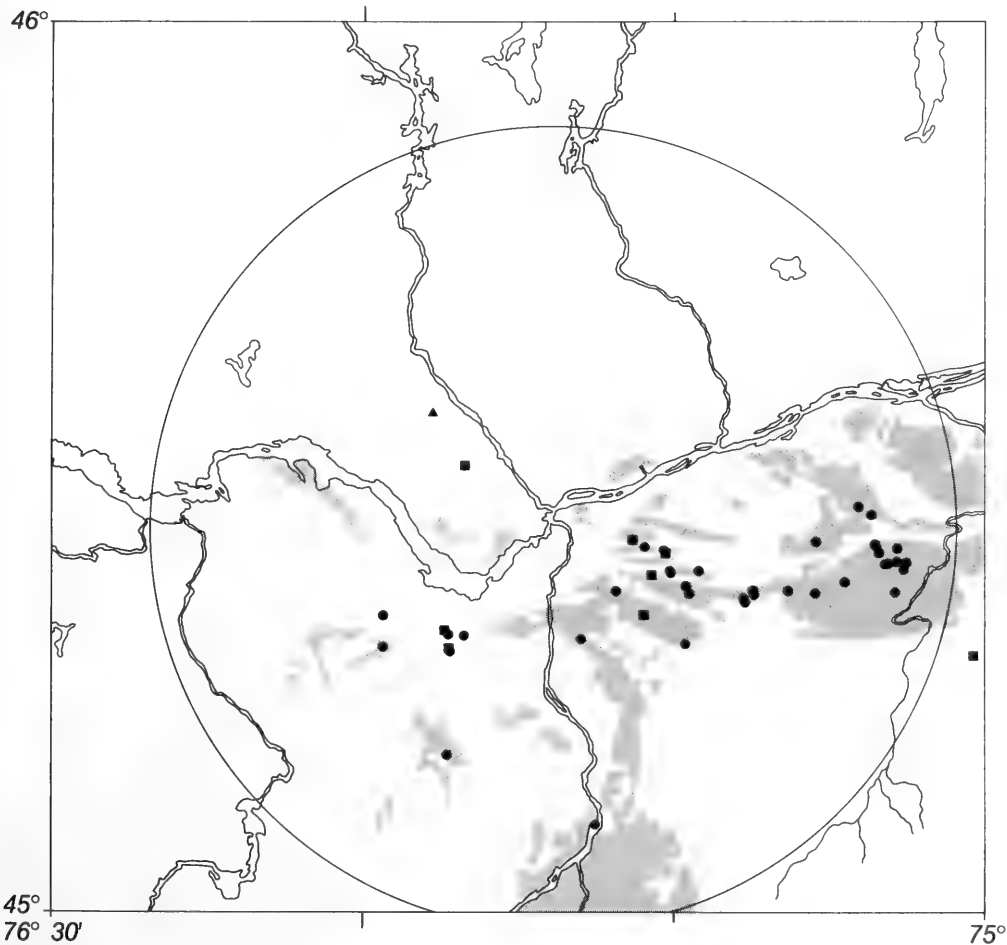
SYNONYM: *Habenaria lacera* (Michaux) R. Brown

One of the more recent orchids to be discovered in the District, *P. lacera* is, on close inspection, an attractive plant, but from a distance it is easily lost among the grasses and weeds with which it grows. It is distinguished by its greenish flowers with long-fringed, tripartite lips. The spur is about 1 to 1.5 times as long as the lip.

DESCRIPTION

- Height:** 11 (30 - 53) 74 cm [127 plants].
- Flowers:** 4 (9 - 31) 56 [61 plants]; light green, pale green, pale yellow, greenish white or yellowish white; lip white at base and occasionally overall, often with sepals more green than lip and petals; flowers generally lighter than surrounding vegetation; laceration of lip quite variable in length and regularity, occasionally almost lacking on central lobe while present on side lobes; in a moderately dense cylindrical inflorescence of some irregularity, but in one case approximately five-ranked; fragrance sweet and floral, becoming much stronger at sunset.
- Leaves:** 1 - 5, grading into an additional 2 - 4 bracts for a total of 4 - 7 leaves and bracts.

- Overwintering State:** a greyish green, broadly conical shoot, appearing above ground beside the current year's stem, in late September; herbarium specimens show the new shoot and partially elongated root often present at anthesis. We have found that the presence of a green shoot does not necessarily mean that a plant will grow from it the next year. The shoot may disappear by early summer even while the roots are still crisp and alive-looking. By September, however, all of these roots will have disappeared.
- Capsules:** dark brown, ellipsoid to oblong, typically 1.4 x 0.4 cm, nearly erect; yield variable, averaging 50% [11 plants].
- Seeds:** brownish orange to brown, released in late September to early October.



Platanthera lacera var. *lacera*: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record, ▲ = literature reference. Areas of major sand deposits on the Lowlands are shaded.



FIGURE 33. *Platanthera lacera* var. *lacera*, sandy old-field habitat, Greenbelt, City of Gloucester, Regional Municipality of Ottawa-Carleton, Ontario, 6 July 1977.

BLOOMING PERIOD: 28 June (2 July - 24 July) 8 August [31 records].

COLONY SIZES: 1 - 123, typically to 60, flowering plants; 10 or fewer in 70% of colonies [47 colonies]; as scattered individuals.

CURRENT STATUS: *Platanthera lacera* is generally rare in Eastern Ontario (Whiting and Catling 1986) and "occasionelle" in Western Quebec (Sabourin 1993) but is capable of becoming locally common when ideal habitat is available. Interestingly, this is more likely to happen as a result of human activity in removing vegetation from sandy areas than by natural means. The distribution map reflects the coincidence of the work of the Native Orchid Location Survey and the "population explosion" of this species in the 1960s and 1970s.

DISTRIBUTION: The Ottawa District is at the regional northern limit of the distribution of this orchid of the Mixed and Deciduous Forest Regions. Within the District, *P. lacera* is localized on sands deposited by the Champlain Sea and subsequent rivers. In the southeast the sands are mainly deltaic and estuarine deposits of the Ottawa River, while those at other sites in Stony Swamp - Bridlewood and Gatineau Park are beaches and shallow deposits of the Champlain Sea.

HABITATS: Two types of sand-based habitats support colonies of this orchid, one in the open and the other in shrubby or forested areas.

Platanthera lacera has been principally a species of open, disturbed sites on moist, acidic sand (pH 4.5 - 5.0) where vegetation is still sparse and sod has not yet developed. In the 1960s, such sites were abundant as a result of the formation of the Greenbelt that left many abandoned fields and borrow pits. Further east, in the Larose Forest, there were many broad, open, sandy roadsides that also provided ideal habitat. But by the 1970s, the old-fields were becoming covered with heavy shrub growth, pine plantations were shading out the Larose Forest, and roadsides in all parts of the District south of the Ottawa River were being maintained by herbicide spraying, leaving little opportunity for plants other than stress-tolerant grasses to survive. Only for a couple of decades was abundant suitable habitat readily available, and now much of that habitat has disappeared.

Typical species accompanying *P. lacera* are Field Horsetail (*Equisetum arvense*), Sensitive Fern (*Onoclea sensibilis*), Marsh Fern (*Thelypteris palustris*), Bladder Campion (*Silene vulgaris*), Dewberry (*Rubus hispidus*), Meadowsweet (*Spiraea latifolia*), Cow Vetch (*Vicia cracca*), Common Milkweed (*Asclepias syriaca*), Heal-all (*Prunella vulgaris*), Brown-eyed Susan (*Rudbeckia hirta*), goldenrods (*Solidago* spp.) and, occasionally, Dwarf Grape Fern (*Botrychium simplex*), Adder's-tongue Fern (*Ophioglossum vulgatum*), rushes (*Juncus* spp.), *Liparis loeselii* and *Platanthera clavellata*.

Rarely, a few plants are found along mesic woodland edges and in clearings among Eastern White Cedar or White Spruce in the Stony Swamp - Bridlewood area. Also in this area, a few plants sometimes occur in clearings in willow and alder thickets. In the southeast, some plants grow in the shade of moist to wet Red Maple forests with Lady Fern (*Athyrium filix-femina*) and Sensitive Fern.

LOCAL HISTORY: *Platanthera lacera* does not appear on any early plant lists for the District (Billings 1867; Fletcher 1880, 1893; Macoun *circa* 1911"). Among the few herbarium specimens, the earliest was collected in 1941 from a "mixed wood" near Old Chelsea in Gatineau Park by H. A. Senn, W. A. Minshall and M. N. Zinck [DAO 17175]. The next was collected 27 years later from a roadside near Ramsayville, City of Gloucester, by W. J. Cody [18110 at DAO]. These and other Department of Agriculture botanists had been botanizing the Ottawa District seriously since the 1940s, but such was the rarity of this orchid at that time that it was collected only twice. Between 1965 and 1975, members of the Native Orchid Location Survey searched the District intensively and discovered 41 colonies, mainly in the southeast.

ABERRATION: In 1970, we found two plants in a colony on the Dolman Ridge beside the Mer Bleue Bog that totally lacked fringes and lobes on the lips, leaving the lips resembling those of *P. hyperborea*. But all other flower parts, including the column as well as the leaves and bracts, were characteristic of *P. lacera*, and so we had to conclude that some mutation had occurred to produce two plants with fringeless lips. (Photograph in J. M. Reddoch and A. H. Reddoch 1987c.) We did not see these two plants again, nor have we observed this aberration since.

Platanthera leucophaea (Nuttall) Lindley

Eastern Prairie Fringed-orchid

Platanthère blanchâtre

SYNONYM: *Habenaria leucophaea* (Nuttall) A. Gray

Platanthera leucophaea is the most recently discovered orchid in the District. It is a rare species that is restricted to fens, a habitat that is also becoming rare. It is one of our largest and most fragrant orchids. This species can be identified by its large white flowers with tripartite, fringed lips and long spurs, as well as by its fen habitat. The spur is about 2 to 2.5 times as long as the lip.

DESCRIPTION

Height: 28 (47 - 73) 93 cm [127 plants].

Flowers: 3 (6 - 17) 29 [60 plants]; sepals light yellow, pale yellow or greyish green with darker veins; lip and petals white often with pale green or greenish white at base of lip, spur greyish yellow; in an open, irregular inflorescence; fragrance in daytime sweet and penetrating, like Common Milkweed (*Asclepias syriaca*) or Dogbane (*Apocynum androsaemifolium*), becoming much stronger in evening.

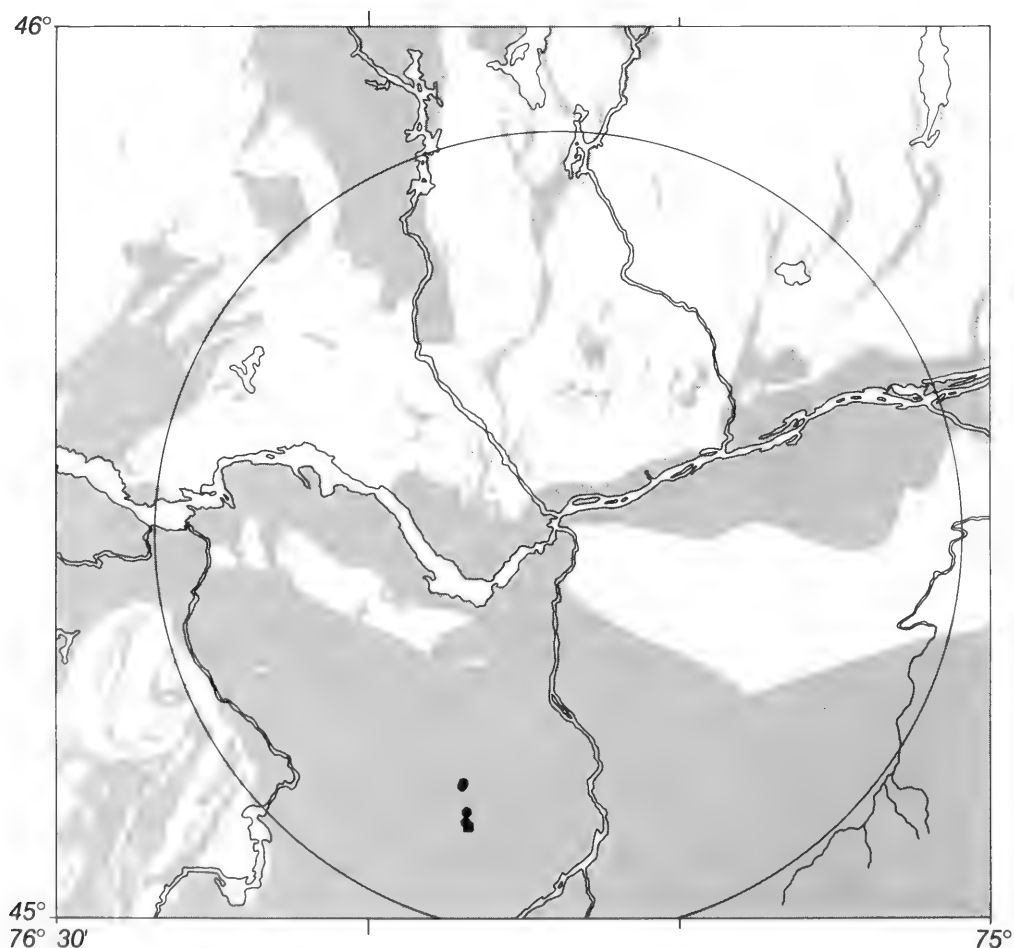
Leaves: 1 - 5, typically 2 - 4, grading to bracts for a total of 5 - 9 leaves and bracts.

Overwintering State: a pale green shoot more than 6 cm tall, 4 mm diameter, the greyish green, acicular tip at the moss surface beside the current year's stem, in October; herbarium specimens show the new shoot usually present at anthesis.

Capsules: brown, oblong, typically 1.7 x 0.4 cm, ascending to erect (see Figure 1c); yield usually greater than 50%, averaging 85% [8 plants].

Seeds: dark brown, released in mid to late September.

BLOOMING PERIOD: 26 June (4 July - 22 July) 22 July [10 records].



Platanthera leucophaea: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record. Major areas underlain by calcareous rock (marble and limestone) are shaded.



FIGURE 34. *Platanthera leucophaea*, sedge fen habitat, Goulbourn Township, Regional Municipality of Ottawa-Carleton, Ontario, 10 July 1977.

COLONY SIZES: 1 - 68 flowering plants [7 records], as scattered (sometimes very widely scattered) individuals; up to an estimated 1000 in one wetlands complex (see below); the number of flowering plants varying widely from year to year.

CURRENT STATUS: rare in the Province of Ontario (White et al. 1982c), very rare (S2) in Ontario (Active List, Oldham 1996*); rare in Canada (Argus and Pryer 1990); vulnerable (1996 list of The Committee on the Status of Endangered Wildlife in Canada (COSEWIC)); rare in the Ottawa District; not known in Quebec (Sheviak and Bowles 1986; Sabourin 1993).

DISTRIBUTION: The Ottawa District is part of a northeastern disjunction of this orchid of the Prairie, northern Deciduous Forest Region and adjacent Mixed Forest Region. There is growing realization that much of the present-day population of the species is in southern Ontario (Sheviak and Bowles 1986). Within the District, *P. leucophaea* is known only in fen habitats in the Richmond Wetlands Complex in the southwest. The next closest extant colony (Greenwood 1968a) is in Leeds County.

HABITAT: Calcareous sedge fens are the exclusive habitat of *P. leucophaea* in Eastern Ontario. The plants grow in the wettest parts of the fen, which means they may be in ankle deep water in wet years and in peat that is damp rather than surface-dry in dry years. The peat is up to two metres deep and pHs are in the range of 6.2 - 6.6. This orchid is accompanied by typical fen species, including the co-dominant sedges, *Carex lasiocarpa* and *C. livida*. At some spots in the two local fens, as well as in the Leeds County fen, *Calopogon tuberosus*, *Liparis loeselii* and *Pogonia ophioglossoides* are also present. Where it was first discovered at the edge of the Richmond Fen, other wet habitat species were present, such as Swamp Milkweed (*Asclepias incarnata*), Northern Bugleweed (*Lycopus uni-*

florus), Common Skullcap (*Scutellaria galericulata*), Marsh Bedstraw (*Galium palustre*) and Spotted Joe-Pye-Weed (*Eupatorium maculatum*).

LOCAL HISTORY: Ewen Todd discovered *P. leucophaea* in the Richmond Wetlands Complex in 1976. The colony consisted of several dozen flowering plants at various places in the fen (Reddoch 1977a). No one knows how long *P. leucophaea* has been in the Richmond Wetlands Complex, but we do know that over a century ago the fen was under water for a period of time when the Jock (Goodwood) River was dammed (Belden 1879).

Two years after the initial discovery, we encountered a second colony in another fen in the wetlands complex. The next year we found more plants in another part of this large fen [DAO 691529]. Local residents told us that this fen is known as "The Burn" because area farmers in the early days used to burn the fen each fall to drive out the deer.

In 1996, Don Cuddy (personal communication) and members of the Ontario Ministry of Natural Resources' Environmental Youth Corps Program studied *P. leucophaea* in the Richmond Wetlands Complex. The results of their sampling led them to estimate the population at between 800 and 1000 flowering plants.

About 1900, Frank Morris found this orchid "on the margin of a mud lake near Smith's Falls..." (Morris 1920), but it had disappeared before 1929 (Morris and Eames 1929). There are several "Mud Lakes" with shoreline fens near Smiths Falls, but *P. leucophaea* is not currently known from any of them (Don Cuddy, personal communication 1986). Smiths Falls is just beyond the Study Area to the southwest.

The earliest evidence for the existence of the Leeds County colony is a collection by W. J. Cody, W. G. Dore and J. H. Soper in 1956 [DAO 17187]. Luer (1975) included illustrations of an inflorescence and a flowering plant in this fen as photographs #3 and #4 on Plate 47.

Platanthera macrophylla (Goldie) P. M. Brown

Goldie’s Round-leaved Orchid

Platanthère orbiculaire de Goldie

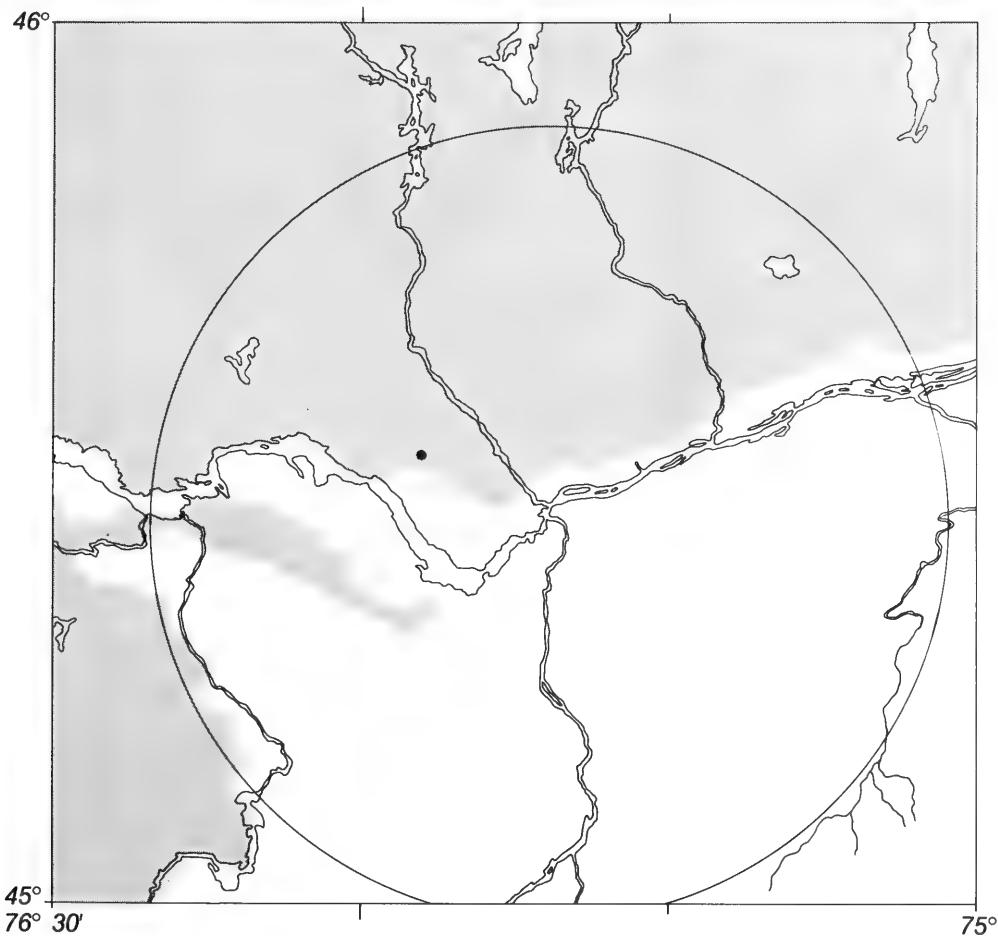
SYNONYM: *Habenaria macrophylla* Goldie

Platanthera macrophylla can be an impressive sight with its bright and sturdy inflorescence floating above two large green leaves in the shade of the forest where little else grows. However, only one plant has been seen in the District. *Platanthera macrophylla* forms a species pair with *P. orbiculata* and both share the distinguishing features of two large roundish leaves flat on the ground, a stem with a few cauline bracts and an inflorescence of long-spurred, greyish green and white flowers. *Platanthera macrophylla* can be separated most reliably from *P. orbiculata* by the average length of its spurs, which is 28 mm or more, and also by the average length of its hemipollinaria, which is 4.6 mm or more. The two species do not differ significantly in height or, in spite of the epithet *macrophylla*, in leaf size. For more details, see the *P. orbiculata* account and Reddoch and Reddoch (1993). Given the small number of plants found in or near the District, additional herbarium records from an area bounded by latitudes 45° and 47°, and longitudes 73° and 77°, were included for the heights, flower numbers and blooming dates given below. Most of these specimens were from north or south of Montreal and included the type specimen from the Island of Montreal (K!).

DESCRIPTION

Height: 34 (35 - 51) 63 cm [18 plants].
Flowers: 9 (9 - 21) 33 [16 plants]; sepals greyish green often with white margin, lateral sepals white at base; petals and lip white, sometimes greyish green toward the tips; spur translucent, white, greyish green distally; in a lax, regular to irregular inflorescence; fragrance not detected by day.

Leaves: 2, basal, shiny, deep green, silvery below.
Overwintering State: likely similar to *P. orbiculata*; herbarium specimens show the new shoot present at anthesis.
Capsules: light brown to brown, ellipsoid to oblong, typically 2.1 x 0.5 cm, vertical even on a sloping rachis (see Figure 1d).



Platanthera macrophylla: ● = our sight record and photographs (see text). The Canadian Shield is shaded.

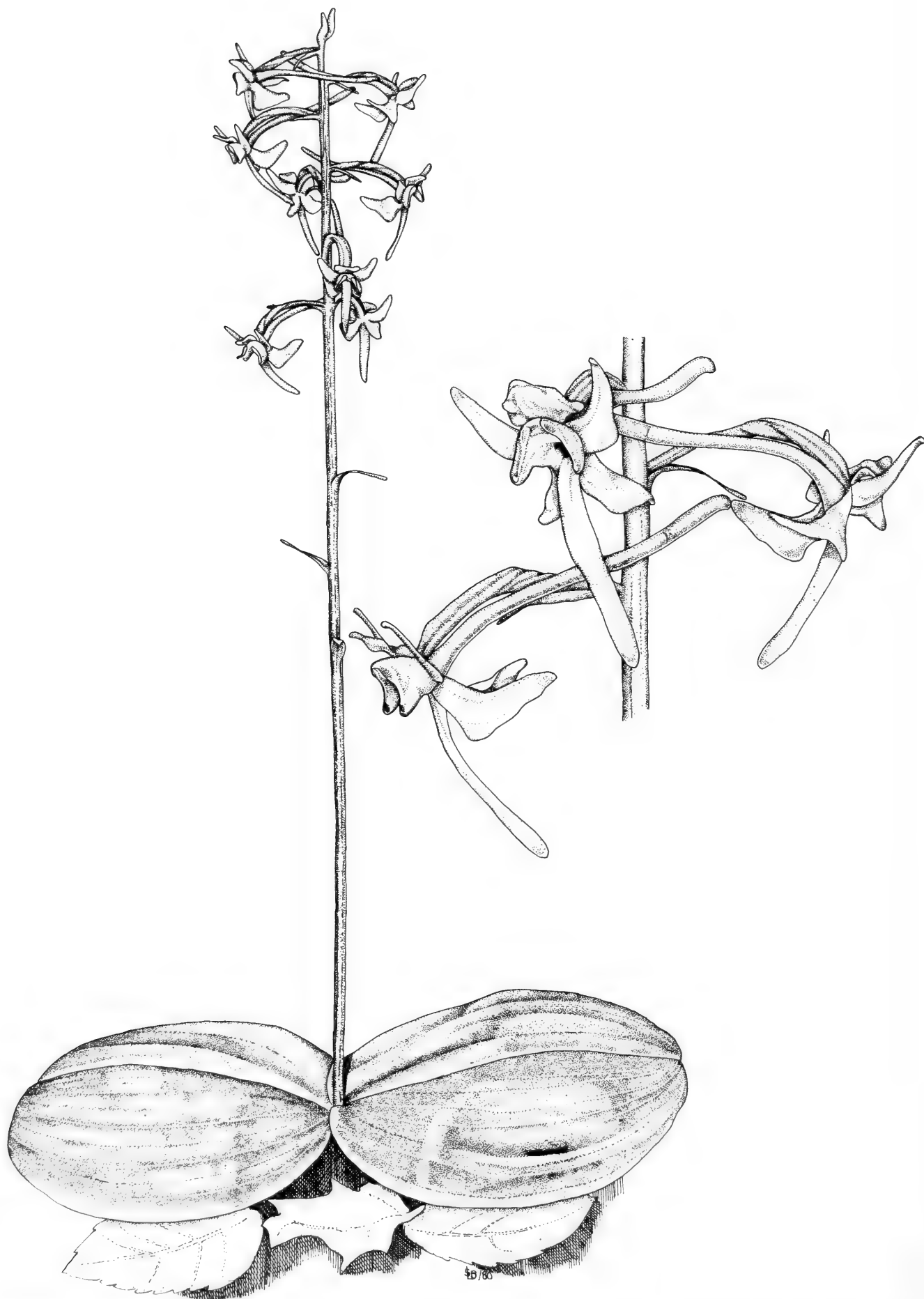


FIGURE 35. *Platanthera macrophylla*, mixed forest habitat, Gatineau Park, Quebec, 15 July 1973; the only record known for the Ottawa District.

Seeds: brown to dark brown, released in mid October.

BLOOMING PERIOD: 2 July (5 July - 25 July) 6 August [16 records].

COLONY SIZES: usually single plants, rarely more.

CURRENT STATUS: rare in the Provinces of Quebec (Bouchard et al. 1983) and Ontario (Reddoch et al. 1982), very rare (S2) in Ontario (Watch List, Oldham 1996*); rare or extirpated in the Ottawa District (no extant colony known).

DISTRIBUTION: The Ottawa District is near the middle of the range of this species of the Mixed Forest Region (Reddoch and Reddoch 1993). Within the District, the only recorded location of *P. macrophylla* is on the Canadian Shield.

HABITAT: The Ottawa District habitat was similar to the typical habitat for the species across its range. It was a fairly mature forest of Sugar Maple and Beech, with a few trees of Eastern Hemlock and Largetooth Aspen, on a low slope beside a beaver pond. There was little herbaceous cover and the mesic forest floor was under a thick layer of leaf mould. This type of habitat is very common on the Shield but one can walk through many kilometres of forest without finding any *P. macrophylla*.

LOCAL HISTORY: As far as we can determine, only

one plant of *P. macrophylla* has been reported in the District. We discovered this plant in 1972 as a pair of leaves on the forest floor near the Champlain Lookout in Gatineau Park, about 25 m from a group of *P. orbiculata* that we were monitoring (see *P. orbiculata* account). In 1973, the plant produced a scape 36.5 cm tall with 11 flowers; it is shown in the Figure. The following year, the plant again produced 11 flowers, this time on a scape 42 cm high. In both 1973 and 1974, the leaves measured 12.5 cm across. In 1975, the plant produced two healthy leaves but did not flower. After that, we could not find the plant again.

A few kilometres east of the Study Area near Montebello, Quebec, William Scott collected a plant in 1890 [TRT 189735].

Patricia Rothschild discovered and photographed a plant several kilometres southwest of the Study Area in Lanark County in the early 1980s. In 1983 and 1984 we examined one flowering plant and three non-flowering plants at the edge of the Eastern White Cedar - Tamarack - Black Ash swamp. The plants were growing on a hummock with the moss *Hylocomium splendens* about 30 cm above the water level (photographs at DAO). Patricia told us in 1989 that no plants bloomed in 1985 or 1986 and the colony disappeared soon after, likely the result of the site being logged.

Platanthera obtusata (Banks ex Pursh) Lindley

Blunt-leaf Orchid

Platanthère à feuille obtuse

SYNONYM: *Habenaria obtusata* (Banks ex Pursh) Richardson

Platanthera obtusata is a small green orchid, widespread in the District but restricted to swamps. The single blunt, basal leaf, with or without a cauline bract, and the relatively small, green and white flowers with short tapering spurs serve to identify this species.

DESCRIPTION

Height: 6 (10 - 17) 25 cm [122 plants].

Flowers: 2 (4 - 12) 20 [116 plants]; sepals light green or greyish green with colourless edges, petals white often with light green along upper edges and veins, lip and spur greyish green with white at base; in an irregular inflorescence; fragrance lacking or faint, sweet or sharp.

Leaf: single, basal and blunt, 10 - 15% of plants with a smaller, narrow cauline bract, in one plant the bract being only about 2 cm above the basal leaf and larger than usual suggesting a second, smaller leaf.

Overwintering State: a greyish green, conical shoot appearing above ground beside the current year's stem by October; Currah, Smreciu, and Hambleton (1990) describe the underground season-

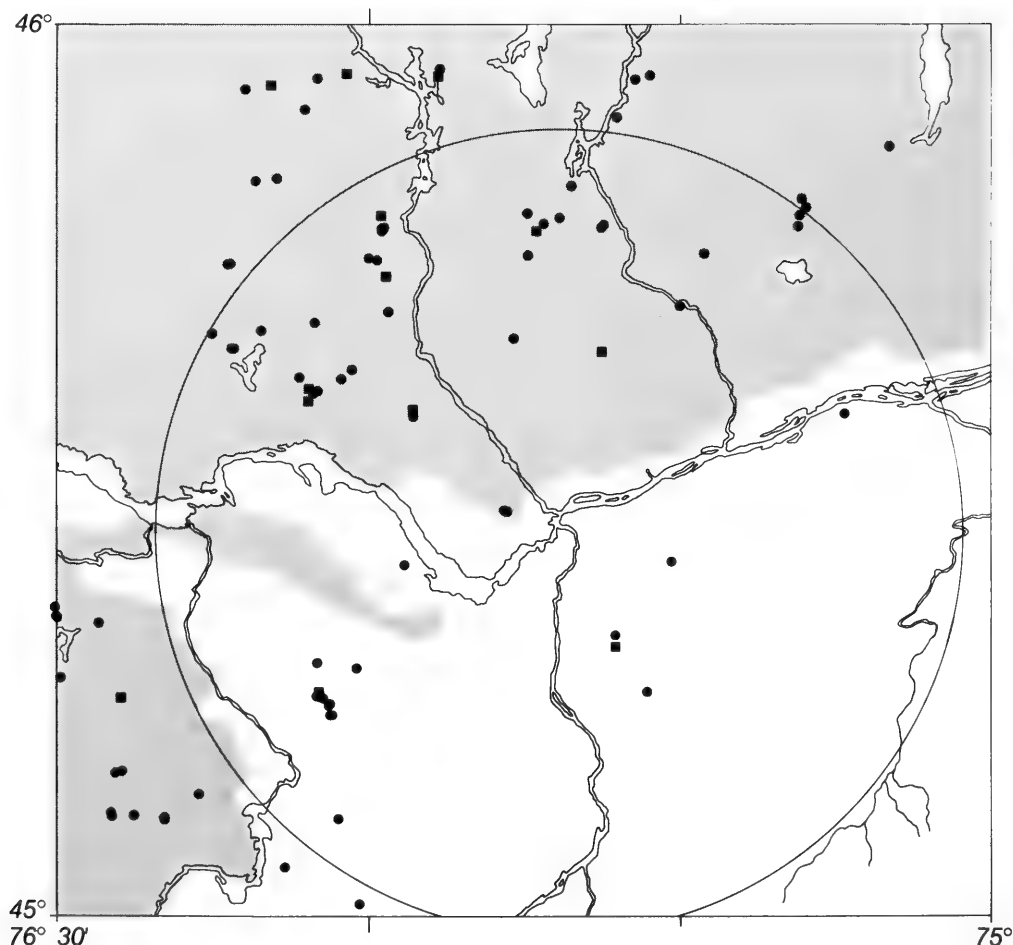
al development of *P. obtusata* in Alberta: at dormancy, the new shoot is subtended by a new, fully elongated, tuberous root and two fleshy roots; a new plant begins development a year before flowering.

Capsules: light brown, ellipsoid, typically 0.6 x 0.3 cm, ascending (see Figure 1d); yield highly variable, averaging 55% [16 plants], appreciably greater than the 14% average reported from Wisconsin for 326 plants (Thien and Utech 1970).

Seeds: greyish orange, released by early October.

BLOOMING PERIOD: 10 June (20 June - 14 July) 25 July [36 records].

COLONY SIZES: 1 - 2000, typically to 200, flowering plants [77 colonies], as scattered individuals and sometimes in clumps of four or five.



Platanthera obtusata: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record. The Canadian Shield is shaded.



FIGURE 36. *Platanthera obtusata*, mixed swamp habitat, La Pêche Municipality (Low Township, Gatineau County), Quebec, 1 July 1980.

DISTRIBUTION: The Ottawa District is near the southern boundary of the North American distribution of this transcontinental orchid. It is a species of the Montane, Boreal and Mixed Forest Regions, as well as the Tundra. Within the District, *P. obtusata* is scattered across the Shield and more sparsely on the Lowlands.

HABITAT: *Platanthera obtusata* frequents the Eastern White Cedar - White Spruce - Black Ash swamps that are common in the District especially in areas of calcareous bedrock. These swamps range in character from fairly closed and dense to high-canopied and open. Plants on the shaded, moist to saturated, swamp floors grow among swamp mosses or in coniferous and deciduous leaf mould. Companion species may include Oak Fern (*Gymnocarpium dryopteris*), Jack-

in-the-pulpit (*Arisaema triphyllum*), Wild Lily-of-the-valley (*Maianthemum canadense*), *Malaxis monophylla*, *Platanthera hyperborea*, Foamflower (*Tiarella cordifolia*), Dewberry (*Rubus hispidus*), Wood-sorrel (*Oxalis acetosella*), Kidney-leaved Violet (*Viola renifolia*), Wild Sarsaparilla (*Aralia nudicaulis*), Bunchberry (*Cornus canadensis*), One-flowered Wintergreen (*Moneses uniflora*), Twinflower (*Linnaea borealis*) and tree seedlings.

EARLY HISTORY: The earliest reference to *P. obtusata* comes from John Macoun's circa 1911* manuscript. He cited only one collection - his own, which he made in 1903 in a swamp near Wakefield, Quebec [Macoun 61032 at CAN]. This swamp may be Chilcott's Swamp, where other collections of this species were made in 1940, 1959 and 1960.

Platanthera orbiculata (Pursh) Lindley

Large Round-leaved Orchid

Platanthère à feuilles orbiculaires

SYNONYM: *Habenaria orbiculata* (Pursh) Torrey

Platanthera orbiculata can be quite distinctive with its greenish white inflorescence rising from between two large green leaves. While it has been recorded widely on the Shield, it is not a common sight. *Platanthera orbiculata* forms a species pair with *P. macrophylla* and both share the distinguishing features of two large roundish leaves flat on the ground, a stem with a few cauline bracts and an inflorescence of long-spurred, green and white flowers. *Platanthera orbiculata* can be separated from *P. macrophylla* by the differences in the average lengths of their spurs and hemipollinaria. In *P. orbiculata*, the average spur length is less than 28 mm, and the average hemipollinarium length is less than 4.6 mm. The two species do not differ significantly in height or, in spite of the epithet *macrophylla*, in leaf size. For more details, see Further Diagnostic Notes below and Reddoch and Reddoch (1993).

DESCRIPTION

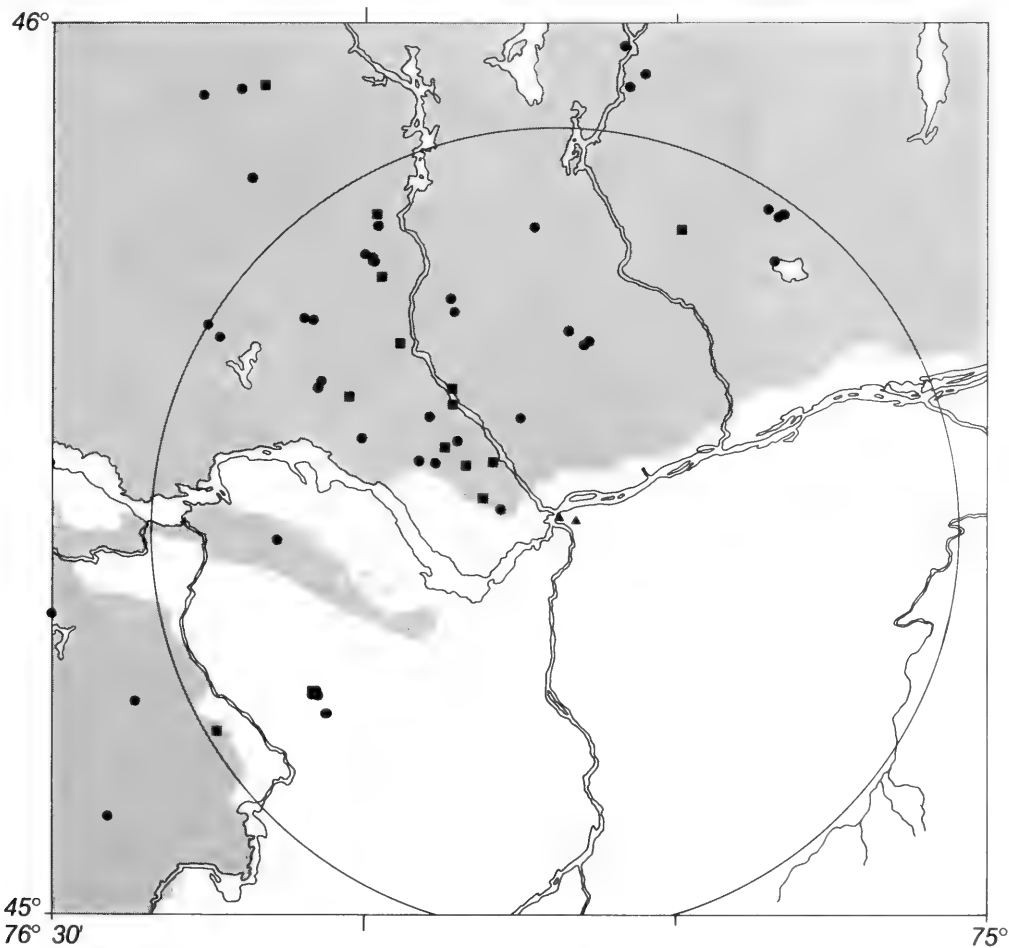
Height: 18 (24 - 38) 58 cm [82 plants].

Flowers: 3 (7 - 17) 27 [68 plants]; sepals greyish green often with white margin, lateral sepals white at base; petals and lip white, sometimes greyish green toward the tips; spur translucent, white, greyish green distally, often horizontal but sometimes descending; in a lax to dense, regular inflorescence; fragrance often undetectable but occasionally faint and sweet in late afternoon, flowers collected and

kept in water moderately fragrant after dark although not at dusk.

Leaves: 2, basal; 1 - 2 on non-flowering plants; shiny, deep green, silvery below, approximately circular, but ratio of length-to-width ranging from 0.6 to 2.5; bracts 1 - 4, typically 3 - 4.

Overwintering State: a greyish green, broadly conical shoot, 1 - 2 cm above ground beside the current year's stem, appearing above ground in late September; Currah, Smreciu, and Hambleton (1990)



Platanthera orbiculata: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record, ▲ = literature reference. The Canadian Shield is shaded.



FIGURE 37. *Platanthera orbiculata*, plant: coniferous forest habitat, La Pêche Municipality (Masham Township, Gatineau County), Quebec, 14 July 1979; flowers: mixed forest, Gatineau Park, Quebec, 9 July 1970.

describe the underground seasonal development of *P. orbiculata* in Alberta: at dormancy, the new shoot is subtended by a new, fully elongated, tuberous root and 5 - 6 fleshy roots; a new plant begins development a year before flowering.

Capsules: light brown to brown, ellipsoid to oblong, typically 1.5 x 0.45 cm, erect; yield usually less than 50%, averaging 30% [23 plants].

Seeds: dark brown, released in early October.

BLOOMING PERIOD: 30 June (6 July - 22 July) 10 August [41 records].

COLONY SIZES: 1 - 190 flowering and non-flowering plants; 10 or fewer plants in 79% of colonies [52 colonies]; usually as scattered individuals but sometimes in pairs and small groups; non-flowering plants typically 1 - 3, but occasionally 5 - 10, times as numerous as flowering plants.

DISTRIBUTION: The Ottawa District is well within the distribution of this transcontinental orchid. It is a species of the Montane, Boreal and Mixed Forest Regions (Reddoch and Reddoch 1993). Within the District, *P. orbiculata* is confined almost completely to the Canadian Shield.

HABITATS: *Platanthera orbiculata* is a plant of coniferous swamps and of a few coniferous and mixed forests. The largest colonies occur in swamps; usually only small numbers are found in forests.

The coniferous swamps are usually of some considerable age. Widely spaced clumps of large Eastern White Cedars are accompanied by a few White Spruce, Tamarack, Black Ash and other trees. The humus of the swamp floor is usually moist rather than wet with the water table below the surface. Only sometimes is the soil saturated. In places, the floor is covered with patches of swamp mosses and in others is bare except for layers of fallen leaves. The herbaceous layer is scant or is luxuriant with such species as Bulblet Fern (*Cystopteris fragilis*), Crested Wood Fern (*Dryopteris cristata*), Oak Fern (*Gymnocarpium dryopteris*), Bluebead-lily (*Clintonia borealis*), *Platanthera obtusata*, Foamflower (*Tiarella cordifolia*), Wood-sorrel (*Oxalis acetosella*), Wild Sarsaparilla (*Aralia nudicaulis*), Bunchberry (*Cornus canadensis*) and One-flowered Wintergreen (*Moneses uniflora*). *Platanthera orbiculata* plants grow on mounds at the bases of trees as well as on the swamp floor.

A few fairly mature forests of Sugar Maple and Beech with scattered conifers or of mainly conifers, particularly Eastern White Cedar, occasionally shelter up to a couple of dozen *P. orbiculata* plants. The plants are rooted in moist leaf mould and sandy loam where there is little other vegetation.

LONG-LIVED COLONIES: In 1969 we discovered and began monitoring a group of *P. orbiculata* plants in a mixed forest near the Champlain Lookout in

Gatineau Park. The plants, ultimately numbering five, grew close together in a roughly curved line separated from each other by 3 to 7 cm. Initially there were two plants, one flowering and one not.

The already vigorous non-flowering plant produced two leaves in 1969 and in the following 10 years. In that decade, it flowered in six of the next eight years, including four consecutive years. It did not appear in the twelfth year and then had one leaf for three more years (until 1983), after which it was not seen again.

The plant that flowered in 1969 continued as a two-leaved plant for six more years, blooming once more, in 1973, and remained as a one-leaved plant for four more years (until 1979). It did not come up after that. Its decline may have been hastened by being often under the large leaves of the adjacent, more vigorous plant described above.

A third plant appeared in 1971 as one leaf beside the preceding plant. It did not come up the next year, put up one leaf for the next three years and then was two-leaved for one year before attempting to flower in the seventh year as a 2.5 cm stunted scape. It flowered again the year after and, after a one-year absence, for the next two years. Sometime during the last flowering, the scape and one leaf were ripped off, likely by a deer. The plant lasted as two leaves for four of the next six years (until 1987) and then disappeared.

A fourth plant came up in 1978 beside the third plant, as one leaf for five of the next seven years, with two absences, and the last two years with two small leaves (until 1987). It never flowered.

A fifth plant produced one leaf each year from 1981 to 1983 and did not flower.

The apparently sudden disappearance of the third and fourth plants at the two-leaf stage in 1987 may have been the result of tree removal by Beavers that exposed the colony to sunlight. We have seen no plants in the area since.

In summary, we can conclude from this study that plants can live for 15 and probably at least 20 years or for as few as three years. The general pattern of development is to produce one small leaf each year for several years, move to two large leaves each year during the plant's prime (which can last at least as long as 11 years), and then end with one small leaf each year for several more years. In their prime, plants can flower at least six times in eight years with four of those years in succession. Once or twice at some random time in even a vigorous plant's life, a plant will fail to come up at all for one year. Leaf sizes, scape heights and flower numbers are at their greatest in the middle of the plant's life.

In 1966, Ed Greenwood (records of the Native Orchid Location Survey) discovered a very large colony of *P. orbiculata* in an Eastern White Cedar - Tamarack - White Spruce swamp that is part of the

Manion Corners Long Swamp in Ottawa-Carleton. This colony declined drastically in the 1970s after this part of the swamp was logged in reaction to the designation of the wetland as a Natural Environment Area in the Region's Official Plan. Several dozen plants survive to the present in the nearby unlogged portions of the swamp. Other colonies, totalling several hundred plants, have been noted elsewhere in this peatland over the years.

EARLY HISTORY: *Platanthera orbiculata* was one of the orchids collected by John Kerr McMorine at Ramsay, Ontario, in 1862 [QK 13099, 13100]. Another early collection was James Fletcher's 1878 specimen from the "Chelsea Mountains, P.Q.", now Gatineau Park [DAO 200660]. Fletcher (1893) cited Rockcliffe and Beechwood as other locations for this species, but we have found no supporting collections. Early botanists considered this species to be rare in the District (Fletcher 1893; Macoun *circa* 1911*).

FURTHER DIAGNOSTIC NOTES: A better separation of *P. orbiculata* and *P. macrophylla* can be made through a discriminant function, in this case the sum

of the average spur length and twice the average hemipollinarium length. This sum will be less than 38 mm for *P. orbiculata*. Numerical studies (Reddoch and Reddoch 1993) show that none of the measured characters permit a perfect separation of these species, the discriminant function being about 99.7% accurate, while the average spur length alone is about 99.0% accurate.

The discriminant function can be useful for dealing with certain plants growing in swamps. Swamp plants tend to have fairly large flowers, although still within the norms of the species, and to have relatively long spurs, but a few of them have average spur lengths exceeding the critical value of 28 mm by 1 or 2 mm. For most of these long-spurred plants, the discriminant function will be less than 38 mm and they will key out to *P. orbiculata*; however, for a few, it will be 38 mm or greater. While these marginally long-spurred plants, in isolation, key out as *P. macrophylla*, it is best to assign them to the same species as the rest of the colony. They lie in the small area of intrinsic overlap in the characters of the two species that causes the less than 100% accuracy noted above.

Platanthera psycodes (Linnaeus) Lindley

Small Purple Fringed-orchid

Platanthère papillon

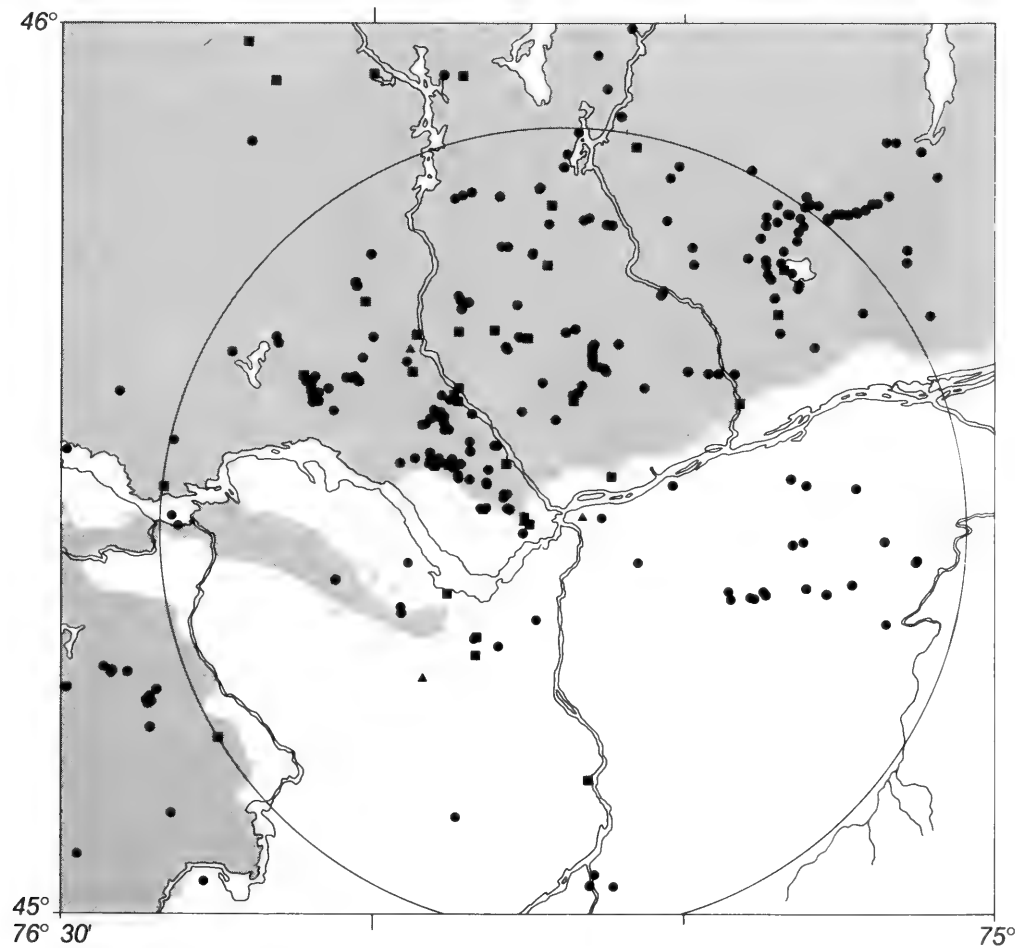
SYNONYM: *Habenaria psycodes* (Linnaeus) Sprengel

Platanthera psycodes is one of our most distinctive orchids and among our tallest. It is widespread in the District, but it is not as abundant as the map suggests because many colonies are rather short-lived. *Platanthera psycodes* closely resembles *P. grandiflora*, with which it occasionally grows. These two species can be easily recognized by their numerous purple fringed flowers on a leafy stem. *Platanthera psycodes* is distinguished from *P. grandiflora* by the shape of the entrance to the spur and by the appearance of the anther sacs. The entrance to the spur in *P. psycodes* is flattened, sometimes almost divided into two smaller entrances, rather than being large and round. The anther sacs are close and parallel instead of diverging downward. *Platanthera psycodes* also tends to have flowers only about half as large as *P. grandiflora*.

DESCRIPTION

Height: 24 (42 - 74) 101 cm [194 plants].
Flowers: 7 (14 - 46) 100 [111 plants], on average about one third more than *P. grandiflora*; commonly lilac or light lilac but also violet white, pale violet or purple; pure white except for pollinia in f. *albiflora* (see Acyanic Form below); base of lip pure white, spurs translucent becoming similar to lip colour near the tip, occasionally darker presumably from small concentration of chlorophyll; fragrance usually daisy-like, sometimes rich, rose-like, but occasional-

ly musty or even like a cat's spray, the latter perhaps related to Brackley's (1985) experience.
Leaves: 2 - 5 (typically 3 - 4) with 2 - 8 (typically 3 - 6) bracts; 2 - 3 on non-flowering plants.
Overwintering State: a greyish green, broadly conical shoot, 0.5 - 2 cm above ground beside the current year's stem, appearing above ground in late September; herbarium specimens show the new shoot and partially elongated roots present at anthesis.
Capsules: brown, oblong, typically 1 x 0.25 cm, ascending to erect; vertical or nearly so even on bent



Platanthera psycodes: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record, ▲ = literature reference. The Canadian Shield is shaded.



FIGURE 38. *Platanthera psychodes*, plant: old-field/stream edge habitat, Aylmer Municipality, Quebec, 4 August 1980; flowers: deciduous forest/stream flood plain habitat, Gatineau Park, Quebec, 22 July 1972.

or fallen stems; yield highly variable, averaging 65% [22 plants].

Seeds: dark brown, released in mid to late September.

BLOOMING PERIOD: 23 June (11 July - 2 August) 18 August [121 records], more extended and two to three weeks later than for *P. grandiflora*.

COLONY SIZES: 1 - 118, typically to 70, flowering plants; 10 or fewer in 71% of colonies [250 colonies], primarily as scattered individuals.

DISTRIBUTION: The Ottawa District is in the northern part of the range of this eastern orchid. It is a species of the Mixed Forest Region and adjacent Boreal and Deciduous Forest Regions (Stoutamire 1974). Within the District, this species is found most commonly on the Canadian Shield and in the southeast on the sands deposited by the Champlain Sea and subsequent rivers.

The number of sight records shown on the distribution map is over-represented compared with the other orchids in the District. Many sightings were the byproduct of Ross Layberry's intensive searches of roadside sedge patches for rare butterflies in the early 1980s.

HABITATS: Colonies are encountered most often among grasses and sedges in sunny, moist or wet roadside ditches, in old-fields and at the margins of ponds, streams and rivers. They also occur among ferns in partially-shaded stream valleys and depressions in fairly mature deciduous forests. (See description of the latter habitat under *P. grandiflora*.) Occasionally, there are plants in alder thickets and in the edges of swamps. The soils are usually moderately acidic sands or sandy humus, but sometimes, on the Lowlands, the soil is Leda clay. In forests and swamps, the substrate is often highly organic.

Open field plants tend to be shorter and stouter and to have more flowers and paler, yellower leaves than plants growing in wetter, more shaded sites.

EARLY HISTORY: John Kerr McMorine collected this species in 1862 at Ramsay, Ontario [QK 13119]. A few years later, Braddish Billings Jr. (1867) included it in his list of species collected during the summer of 1866, but we have not found a voucher for verification. Other early collections were made by Robert B. Whyte in 1875 (Macoun *circa* 1911*), Henry M.

Ami in 1879 [MTMG 3383, 26283] and James Fletcher in 1881 [MTMG 25529].

In 1917, W. Hague Harrington had this to say: "The tall purplish spikes of bloom appear some seasons in great abundance and beautify the low meadows and roadsides which are their usual habitat. The Beaver Meadow, Hull, P.Q., was often richly adorned in July with these charming plants but, alas! the devastation and ravages of the extensions of Hull are fast destroying the beautiful scenes to which the Field-Naturalists' Club frequently resorted to study the rich fauna and flora".

ACYANIC FORM: The white-flowered *P. psycodes* f. *albiflora* (R. Hoffman) Whiting and Catling has turned up at least four times in the last century, each time in the southern Quebec part of the District. The first report was in 1888: "A beautiful albino form of *Habenaria psycodes*, Gray, [sic] was collected this past summer near Ironsides by Mr. H. M. Ami. It was growing amongst a number of plants of the ordinary colour and was of vigorous growth." (Fletcher, Small, and Baptie 1888). The whereabouts of this collection is not known at present.

Ed Greenwood observed two such plants near Buckingham in 1962 (personal communication 1977). Some 20 years later, the site had become overgrown due to succession and we could find no *P. psycodes* there. In 1980, Ross Layberry discovered the albino form in a colony of about 35 typical plants along a stream edge in a farm field south of Mountain Road near lower Gatineau Park. At this colony we saw two plants with pure white flowers and buds (A. H. Reddoch and J. M. Reddoch 1987b, [DAO 691538]) and one other plant with white flowers and buds but with a very pale pinkish colour on the uppermost flowers and the outsides of the buds. The site of the colony, by a stream at the edge of a field, had evidently been cut and ploughed in previous years and was ploughed again a few years later. In 1982, Clarie Frankton (personal communication 1987) found two albinos with a number of typical plants in the southern part of Gatineau Park.

ABERRATION: On some plants that we examined in 1976 in Cumberland Township, the flower petals were appreciably lighter than the sepals, giving a two tone effect. At that time, the roadside ditches where these plants grew were being sprayed for weed control. (See Long-lived Colonies under *P. grandiflora* for a further description of this colony.)

Pogonia ophioglossoides (Linnaeus) Jussieu

Rose Pogonia

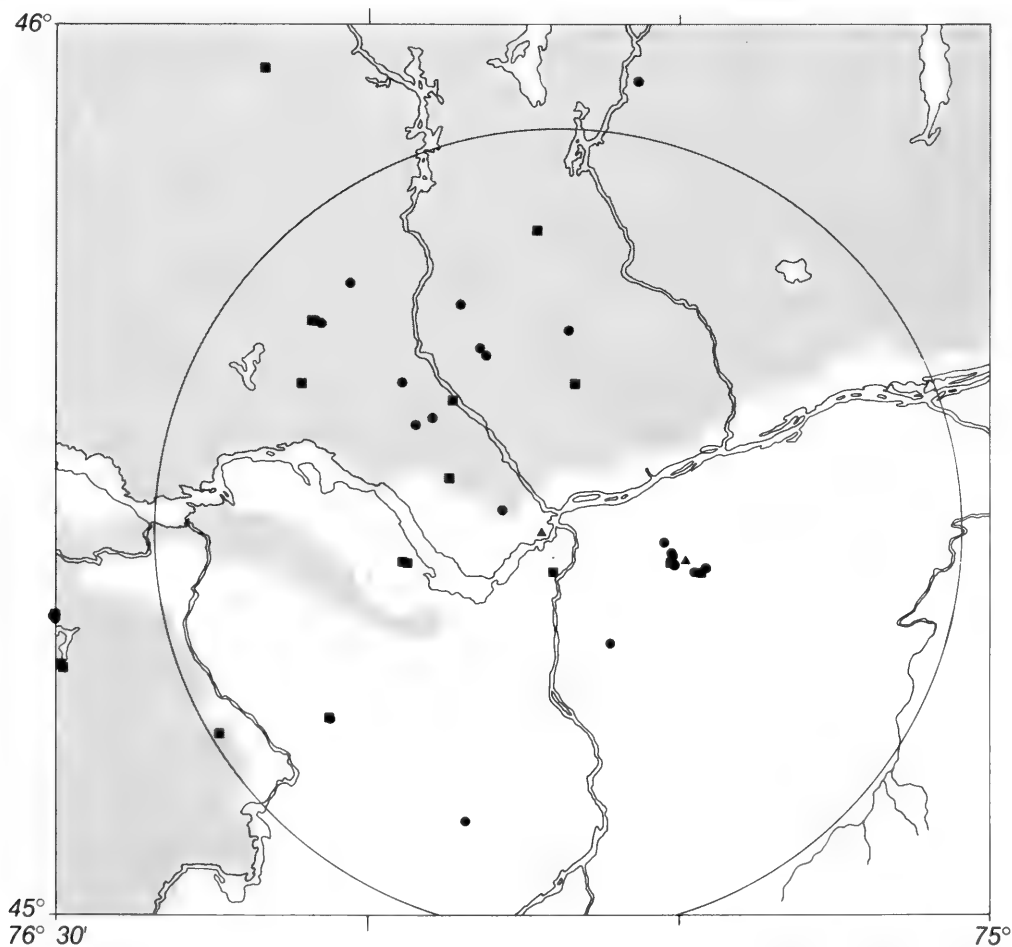
Pogonie langue-de-serpent

Pogonia ophioglossoides is one of the three pink or purple orchids to be found in the fens of the District. It can be separated from the other two, *Calopogon tuberosus* and *Arethusa bulbosa*, by the elliptical cauline leaf, the similar but somewhat smaller floral bract, the lip in the usual lower position, in contrast to that of *C. tuberosus* and the spreading lateral sepals, in contrast to the erect ones of *A. bulbosa*.

DESCRIPTION

Height: 10 (18 - 32) 62 cm [264 plants].
Flowers: 1, occasionally 2; sepals and petals usually purplish pink, sometimes more or less intense: purplish red, greyish magenta, pink or pinkish white; margin of lip similar with more intense lines; centre of lip with light yellow or lighter papillae near the end and finer fibres of similar or greener colour near the base; fragrance moderate, sweet, strawberry-like, or lacking; Luer (1975) displays a photograph (Plate 65, #4) of a typical flower in the open sedge fen near Poltimore, Quebec.
Leaf: 1, cauline, rarely also with 1 basal, petiolate, lanceolate leaf; 1 or 2, petiolate, lanceolate, on non-flowering plants.
Overwintering State: a greyish green shoot, 1 - 1.5 cm high, at the base of the current year's stem

about 4 cm deep in the moss substrate, in September; herbarium specimens show the new shoot and partially elongated roots present at anthesis.
Capsules: brownish orange to light brown, ellipsoid to oblong, typically 2.1 x 0.5 cm, vertical even on a sloping rachis, flowers frequently dehiscent from capsule; yield usually high, 50% or more [60 plants] (10% - 100% in Wisconsin (Thien and Marcks 1972)).
Seeds: brown, released in late September.
BLOOMING PERIOD: 8 June (23 June - 17 July) 14 August [79 records].
COLONY SIZES: 1 - 2500, typically to 1000, flowering plants [40 colonies], as scattered individuals.
DISTRIBUTION: The Ottawa District is near the northern edge of the range of this eastern orchid. It is a



Pogonia ophioglossoides: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record, ▲ = literature reference. The Canadian Shield is shaded.



FIGURE 39. *Pogonia ophioglossoides*, left plant: moist, sandy borrow pit, Borthwick Ridge, Mer Bleue Conservation Area, Ontario, 26 June 1973; right plant: sedge fen, Val-des-Monts Municipality (Wakefield Township, Gatineau County), Quebec, 16 July 1977; flower: sedge mat, Black Lake, Gatineau Park, Quebec, 9 July 1969.

species of the Mixed, Deciduous and Southeastern Coastal Plain Forest Regions. Within the District, *P. ophioglossoides* is confined to several peatlands and related areas scattered across the Canadian Shield and the Lowlands.

HABITATS: Open sedge fens are the most common habitat for *P. ophioglossoides* and the habitat where it occurs in largest numbers. Both calcareous sedge fens (intermediate to rich fens) and the minerotrophic edges of bogs (poor fens) are occupied, as are floating pond-edge fens in both categories. The orchids grow on the wet fen floor among such mosses as *Sphagnum warnstorffii* and *S. magellanicum*. *Calopogon tuberosus* almost always accompanies *P. ophioglossoides* in these habitats. (For more details on accompanying calcareous sedge fen vegetation, see Appendix 2.)

Certain borrow pits, shore-edge fallen logs and floating boom-logs also have provided suitable habitats for *P. ophioglossoides*.

During the 1970s, a colony flourished on the moist to wet floor of a borrow pit on the Borthwick Ridge beside the Mer Bleue Bog. Removal of overburden a decade earlier left a layer of bare sand over impermeable clay that was then colonized by both peatland and old-field plants. A patch of *P. ophioglossoides* developed in one of the more low-lying areas (pH 5.0), along with saplings of Tamarack, Trembling Aspen, Grey Birch and Speckled Alder. Prominent herbaceous plants included Field Horsetail (*Equisetum arvense*), Round-leaved Sundew (*Drosera rotundifolia*), Meadowsweet (*Spiraea alba*), Red Clover (*Trifolium pratense*), Sheep Laurel (*Kalmia angustifolia*), Labrador Tea (*Ledum groenlandicum*) and Small Cranberry (*Vaccinium oxycoccos*). *Polytrichum commune* was the common moss. The colony expanded to more than a hundred flowering plants and many more non-flowering plants in the years 1977 to 1980. During that time, Rose Chafers (*Macrodactylus subspinosus*) infested the colony and ate the flowers. By 1987, the area was so overgrown that it was difficult to recognize and there was only one flowering plant left.

Meanwhile, in a similar, but slightly drier, habitat on the Dolman Ridge beside the Mer Bleue Bog, 11 flowering plants of *P. ophioglossoides* appeared for one year (1973), growing along with *Calopogon tuberosus* and other orchids. Although there were hundreds of flowering plants of *P. ophioglossoides* in poor fen habitat across the lagg to provide a continual source of new seed, subsequent dry summers and increased growth of shrubs and trees quickly made this site unsuitable for *P. ophioglossoides*, and, ultimately, for the rest of the orchids. (See *Calopogon tuberosus* account.)

Somewhat waterlogged and decayed fallen trees along undisturbed lake edges can provide suitable habitat for *P. ophioglossoides*. At Lac Bonin, in

Quebec cottage country, two dead, partially floating Eastern White Cedar trees supported a small colony of this orchid for at least two decades, from 1973 to 1993 (Ed Dodson, personal communication 1996). Although the habitat did not change, no flowering plants were present in 1994 and 1995 (*idem*). The trees remained anchored to a shore lined with Sweet Gale (*Myrica gale*) and Leatherleaf (*Chamaedaphne calyculata*) while vegetation developed at two places on them over the years. In 1983, when Ed Dodson showed the site to us, we counted 10 flowering plants of *P. ophioglossoides* and two of *Liparis loeselii*. They were accompanied by Royal Fern (*Osmunda regalis*) (< 20 cm high), Wild Iris (*Iris versicolor*), Sweet Gale, Pitcher-plant (*Sarracenia purpurea*), Round-leaved Sundew, Marsh St. John's-wort (*Triadenum virginicum*), Leatherleaf (< 40 cm high), Cut-leaved Bugleweed (*Lycopus americanus*) seedlings and Red Maple seedlings. *Campylium stellatum*, *Sphagnum contortum* and *S. turgescens* were the mosses present.

Partially waterlogged and decayed boom-logs on the Gatineau River between Chelsea and Cascades have provided habitat for many local plants, including *Liparis loeselii* (Bayly 1972) and *P. ophioglossoides* (Isabel Bayly, personal communication 1977). Boom-logs were large squared timbers of Douglas-fir, Western Hemlock or Western Red Cedar (Bayly 1972) that were chained together to restrain cut logs en route to the mills on the Ottawa River. Most plants living in this harsh environment of glaring sun and low fertility remained dwarfed in size, even while becoming fully mature (Bayly 1972); however, the *P. ophioglossoides* plant collected by Martha Camfield in 1959 at Ramsay's Crossing (between Burnet and Cascades) was a relatively normal 23 cm high [CCO 3482]. About a decade ago, when trucks became the sole means of transporting cut logs, the boom-logs were removed (Isabel Bayly, personal communication 1996).

LONG-LIVED COLONY: On 8 July 1878, James Fletcher [1791 at DAO] collected *P. ophioglossoides* at Black Lake in what is now Gatineau Park. He probably made the collection from the partially floating, poor fen mat (pH 5.0) at the southeast end of the lake. The colony of *P. ophioglossoides* is still extant. We counted 80 flowering plants there in 1969; however, Beavers dammed the outlet stream in 1983, raising the lake level half a metre and inundating much of the mat (J. M. Reddoch and A. H. Reddoch 1987d). From the shore in 1995, we spotted 37 flowering plants on the remnant mat; in 1996 we were able to see 19. Accompanying vegetation in 1996 included Marsh Fern (*Thelypteris palustris*), Water Arum (*Calla palustris*), sedges (*Carex* spp.), Wild Iris, Marsh St. John's-wort, Leatherleaf and *Sphagnum* spp.

EARLY HISTORY: Braddish Billings Jr. collected *P. ophioglossoides* at Dow's Swamp on 9 July 1860

[QK 13410] and on 8 June 1861 [QK 13412, -13, CAN 227241], likely on the sedge mat surrounding the small pond shown in the 1925 air photo (Reddoch 1978b). He collected *Calopogon tuberosus* there on the former date and noted that both species were rare. He did not include *P. ophioglossoides* in his list of plants collected during the summer of 1866 (Billings 1867), although he did have *C. tuberosus*. There appear to be no other collections from Dow's Swamp.

In 1862, J. K. McMorine collected both *P. ophioglossoides* and *C. tuberosus* from Ramsay,

Ontario. The date cited for the former species is 9 July [QK 66723, 66727].

Robert B. Whyte's 1879 collection from the Mer Bleue Bog cited by John Macoun (*circa* 1911*) appears to be the earliest of many collections made over the years from the west end of the peatland between Blackburn Hamlet on the north and Carlsbad Springs on the south. Several early authors commented on the great abundance of *P. ophioglossoides* in the Mer Bleue (Macoun, Whyte, and Fletcher 1884; Fletcher 1893; Macoun *circa* 1911*).

Spiranthes casei Catling and Cruise var. *casei*

Case's Ladies'-tresses

Spiranthe de Case

One of the latest orchids to bloom, *S. casei* was first collected here only a half century ago and was not recognized as a separate species until two decades ago (Catling and Cruise 1974). *Spiranthes casei* is distinguished from the more abundant and widespread *S. cernua* by its off-white rather than pure white flowers that are less than 8 mm long and are arranged in a single, corkscrew-like spiral.

DESCRIPTION

Height: 14 (21 - 32) 45 cm [211 plants], on average about 4 cm taller than *S. cernua*.

Flowers: 4 (13 - 26) 50 [178 plants]; yellowish white, rarely almost white, with a greyish yellow patch at the centre of the lip visible from above and below, usually with greyish green to deep green at the base of the tepals; more or less horizontal; in a single corkscrew spiral of up to 8 turns, rising to the left or right, with 3 - 8, typically 5 - 6 flowers per turn; no odour detectable, but a strong sour odour when bruised or collected.

Leaves: 3 - 4, basal, withering to leave 0 - 3 at anthesis; and 1, cauline, near the base, sometimes bract-like, starting to wither at anthesis.

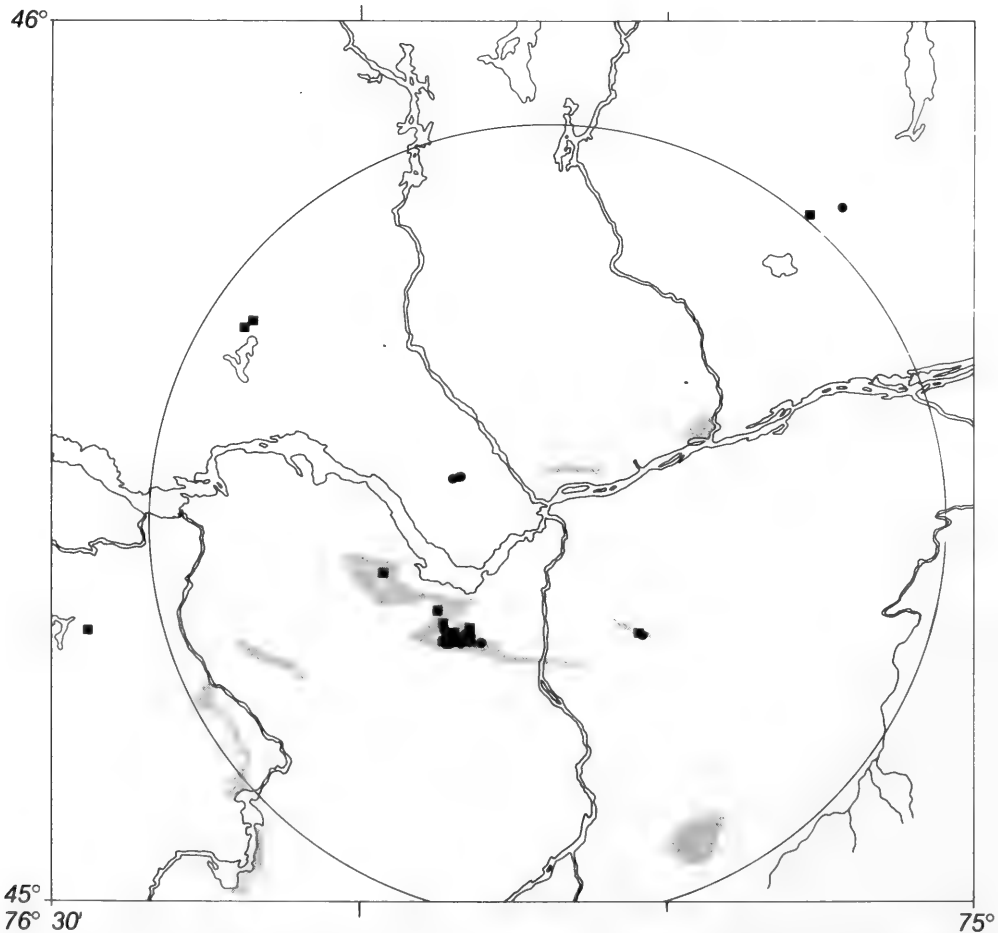
Overwintering State: a lanceoloid shoot or a pair

of leaves 1 - 2 cm in length surrounding a central bud, appearing above ground beside the current year's stem at anthesis or shortly after; shoots appearing earlier and developing further on decapitated and non-flowering plants; Mousley (1924b, sub *S. cernua* var. *ochroleuca*) reported that the new shoot appeared at the base of the flowering stem at anthesis and the 3 - 4 fleshy roots made their appearance the following spring, near Hatley, Quebec.

Capsules: light brown, ellipsoid, typically 0.6 x 0.3 cm, ascending (see Figure 1d); yield approaching 100%.

Seeds: greyish orange, released in late October.

BLOOMING PERIOD: 10 August (21 August - 12 September) 23 September [42 records], about the same duration as *S. cernua* but a week earlier.



Spiranthes casei: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record. Areas underlain by sandstone are shaded.



FIGURE 40. *Spiranthes casei*, old-field habitat, Stony Swamp Conservation Area, Regional Municipality of Ottawa-Carleton, Ontario, 24 August 1980.

COLONY SIZES: 1 - 100, typically to 50, flowering plants, 10 or fewer in two-thirds of the colonies [32 colonies]; as scattered individuals or occasionally as pairs.

CURRENT STATUS: rare in the Province of Quebec (Bouchard et al. 1983).

DISTRIBUTION: The Ottawa District is at the northern edge of the range of this orchid of the Mixed Forest Region (Catling 1982b; New York Flora Association 1990). Within the District, *S. casei* is restricted in the Lowlands to regions of sandstone bedrock of the Nepean and March Formations (shaded areas on map). The major concentration of colonies has been recorded in the Stony Swamp Conservation Area and adjacent Bridlewood. On the Canadian Shield, *S. casei* is found in scattered locations on sand deposits or over acidic Precambrian rocks (J. M. Reddoch and A. H. Reddoch 1987a).

HABITAT: *Spiranthes casei* favours old-fields and woodland clearings in areas of acidic rock where weeds and grasses are neither high nor dense. Poverty Grass (*Danthonia spicata*) is usually the dominant vegetation. Here, plants grow in deep or shallow sand or sandy loam that is moist or somewhat drier. Where there are expanses of exposed bedrock, plants are scattered along soil-filled crevices and on adjacent open ground. Some associated species are fruticose lichens, Bracken (*Pteridium aquilinum*), Meadowsweet (*Spiraea latifolia*), Blueberry (*Vaccinium angustifolium*), Slender Gerardia (*Gerardia (Agalinis) tenuifolia*), Gray Goldenrod (*Solidago nemoralis*) and, increasingly in Stony Swamp, Stiff Eyebright (*Euphrasia stricta*).

Near White Lake, the unusually high concentration of 39 flowering plants was observed in a 1.4 m² area of a sandy rural lawn (Adolf Vogg, personal communication 1994).

Spiranthes cernua is almost always a companion plant. Where sites are relatively flat-lying, as most of them are, the two *Spiranthes* are intermingled. Where the sites are sloped, *S. casei* usually is situated on the higher, drier ground, while *S. cernua* inhabits the moister end of the gradient. *Spiranthes lacera* occasionally accompanies *S. casei* on drier

sites. Colonies on dry sites are particularly affected by drought. In some years, very few or no plants flower.

LONG-LIVED COLONIES: Many colonies of *S. casei* last for many years because the soil is too shallow or too infertile to support dense vegetation and woody plants. In a few locations, annual mowing is the agent that controls competing growth.

In Stony Swamp, the colony recorded by a 1972 collection continues to thrive. Several dozen plants are scattered in the sand-filled cracks (pH 4.5) of flat-lying exposures of sandstone in a large clearing surrounded by second-growth mixed forest. A similar number of *S. cernua* plants run along the lower edge of the opening.

At Kingsmere in Gatineau Park, a colony of up to 55 plants of *S. casei* and a few *S. cernua* has survived since at least 1981 because the field they grow in is mowed annually to keep down woody plants. Here, the gneiss bedrock (Hogarth 1970) is partially exposed but generally covered thinly to deeply with sand. It has been the usual practice for the National Capital Commission to mow Gatineau Park fields in September to avoid disturbing ground-nesting birds. But since mowing at this time sometimes cuts down flowering *S. casei* and it is N.C.C. policy to protect provincially-rare flora, the staff is trying to arrange for mowing of that field to be done either later in the fall or very early in the spring.

LOCAL HISTORY: We have found no record of *S. casei* in the Ottawa area before the late 1940s. In 1947, W. J. Cody, J. A. Calder and H. L. Mitchell made a collection [DAO 89678] near Jarnac, Quebec, just outside the 50-km circle to the northeast (Reddoch and Reddoch 1974). In 1946, 1947 and 1948, L. McI. Terrill collected *S. casei* north of Merrickville, about 5 km south of the District [CAN 338026, -27, -28]. *S. casei* was first collected in Gatineau Park in 1968 and in Stony Swamp in 1972.

During the late 1980s and the 1990s, housing construction in Bridlewood destroyed all of the colonies there, almost half of the population recorded a decade earlier in the combined Stony Swamp - Bridlewood area.

Spiranthes cernua (Linnaeus) L. C. M. Richard

Nodding Ladies'-tresses

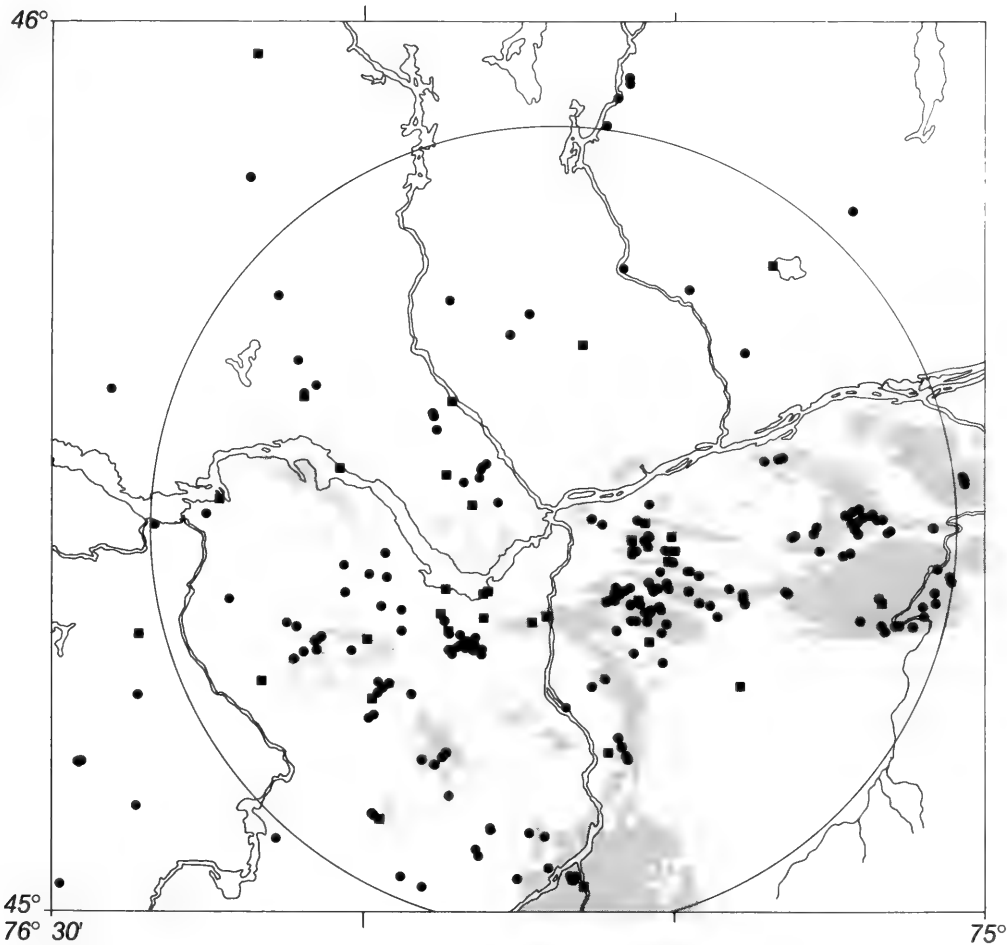
Spiranthe penchée

The last orchid of the season, *Spiranthes cernua* is one of the most abundant, although it did not become so until comparatively recently. In the field, it can be distinguished from *S. casei* by its pure white flowers greater than 8 mm in length, often with a faint yellowish colour in the throat, from *S. romanzoffiana* because its flowers are tubular and more or less horizontal rather than hooded and ascending, and from the other *Spiranthes* by its late blooming period, September, and lack of strong yellow or green in the throat.

DESCRIPTION

Height: 6 (16 - 28) 43 cm [1327 plants].
Flowers: 1 (8 - 21) 40 [492 plants]; white, often faint yellowish white or yellowish grey near the centre of the lip, often with a narrow band of faint greyish green across the bases of the tepals; in 1, 3 or 4 ranks (see Spirality below); fragrance usually rich, sweet, coumarin-like, rarely, lacking.
Leaves: 4 - 5, basal, starting to wither a month before anthesis, leaving 0 - 2 by the time the last flowers open; and 1, cauline, near the base, sometimes bract-like, starting to wither at anthesis or shortly after; 2 - 4 on non-flowering plants.
Overwintering State: a lanceoloid shoot or a pair of leaves 1 - 2 cm in length surrounding a central bud, appearing above ground beside the current

year's stem at anthesis or shortly after; shoots appearing earlier and developing further on decapitated and non-flowering plants (see Seasonal Development below); Mousley (1924a, b) in describing the underground development of *S. cernua* near Hatley, Quebec, reported that the new shoot appeared at the base of the flowering stem at anthesis and that the first pair of root buds was evident in the early spring of the following year; by late May, one or two additional fleshy roots had been produced.
Capsules: light brown, ellipsoid; typically 0.7 x 0.3 cm, ascending; yield approaching 100%.
Seeds: light brown, released in mid to late October.
BLOOMING PERIOD: 15 August (28 August - 21 September) 16 October [125 records].



Spiranthes cernua: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record. Areas of major sand deposits on the Lowlands are shaded.

COLONY SIZES: 1 - 5000, typically to 500, flowering plants [235 colonies]; as scattered individuals, occasionally in twos and threes, and rarely up to groups of five.

CURRENT STATUS: one of the most abundant orchids in the District.

DISTRIBUTION: The Ottawa District is near the northern limit of the range of this eastern species. The range encompasses much of the Mixed, Deciduous and Southeastern Coastal Plain Forest Regions and the adjacent American Prairie. Within the District, most colonies are located on sands deposited by the Laurentian ice sheet, the Champlain Sea and subsequent rivers. These sands are mainly in the Lowlands, especially in the southeast, but they also occur in scattered locations on the Shield.

HABITATS: The principal habitat in terms of number and size of colonies is open, wet to moist expanses of acidic sand with sparse plant cover. Human activities have created these conditions in broad, shallow roadside ditches, abandoned sand pits and scrapes, and fallow fields and pastures. Common companion plants are Variegated Horsetail (*Equisetum variegatum*), Slender Gerardia (*Gerardia (Agalinis) tenuifolia*), Meadowsweet (*Spiraea latifolia*) and other roadside weeds. On the ridges adjacent to the Mer Bleue Bog, additional companion plants include Round-leaved Sundew (*Drosera rotundifolia*), Labrador Tea (*Ledum groenlandicum*) and Sheep Laurel (*Kalmia angustifolia*).

With increasing shade and competition from other herbs, colonies dwindle in size and eventually may disappear. However, individuals or small numbers may persist among moderately dense, knee-high grasses, in young, semi-open shrub thickets and woodlands, and in residual openings and along trails in more mature second growth forest.

A few sizeable colonies are also encountered in naturally disturbed settings on the wet to moist shores of some small Shield lakes and along the Ottawa River west of the city. Plants have been found on both sandy and clayey beaches, in exposed soil or among rocks, and, rarely, in shallow water.

Some colonies thrive in thin, dryish to moist soil, usually sand but sometimes clay, over flat-lying bedrock. Bedrock under *S. cernua* includes sandstone and gneiss (pH 4.0), and limestone and marble (pH 7.5).

Occasionally, the substrate has a moderate component of humus, but there is no evidence in the District for a peatland habitat.

LONG-LIVED COLONIES: Colonies can continue to flourish for decades under conditions that maintain suitable habitat, for example, mowing, re-exposure of bare substrate and the presence of soil too shallow or infertile for competing vegetation to thrive. A gradient within a habitat that allows the colony to sur-

vive in one part after the rest of the habitat has been altered can be important.

There has been a colony of several hundred *S. cernua* in a shallow, sandy ditch (pH 5.0) beside Anderson Road in Gloucester since at least 1973. The habitat is maintained by mowing. Installation of a gas pipeline in the mid-1980s obliterated most of the colony except for a few plants along the fence-line. Within a few years, several dozen plants appeared on the newly-exposed sand in the ditch and numbers quickly increased to their previous level. (See also Seasonal Development below.)

Up to 500 plants of *S. cernua* have flowered on the Borthwick Ridge adjacent to the Mer Bleue Bog since at least 1966. For most of that time, they grew in wet to moist sand (pH 4.5 - 5.0) in a seasonally-flooded scrape that increasingly was being shaded by willows. Companion plants included the species listed above for the sand habitat, as well as *Pogonia ophioglossoides*, Bog Clubmoss (*Lycopodium inundatum*) and Marsh Fern (*Thelypteris palustris*). The *S. cernua* plants persisted into fairly deep shade before disappearing along with all other herbaceous plants. However, several dozen plants still can be found adjacent to the scrape in moist sand at slightly higher elevations in the dappled shade of second growth Trembling Aspen, Grey Birch, Tamarack, Red Maple and Speckled Alder. The sparse ground cover is dominated by *Polytrichum* mosses and includes Ground-cedar (*Lycopodium complanatum*) and Labrador Tea. Throughout the known history of this colony, four-ranked plants have been dominant, although ranking was less well-defined in the treed habitat (see Seasonal Development below for a description of the effects of shade).

Patches of shallow sand on exposed flat-lying sandstone (pH 4.0) in the Stony Swamp Conservation Area have supported a mixed colony of several hundred *S. cernua* and several dozen *S. casei* since at least 1977. Conditions do not support a dense growth of vegetation and Poverty Grass (*Danthonia spicata*) is the most common herb.

Whether a colony is allowed to bloom depends on the timing of the operation that maintains the habitat. A striking example was the appearance in 1980 of several hundred flowering plants in a rocky pasture on the Hendrick farm at Old Chelsea, Quebec. The cattle and horses are moved from field to field throughout the season. Apparently only that year was a field free from livestock from July to September. We do not know for how many years the plants were present in the field before or after 1980.

See also this heading under *S. casei*.

EARLY HISTORY: The earliest records of *S. cernua* in the Ottawa District appear to be collections made by F. P. Clappison in a "beaver meadow" at Kemptville in 1898 [TRT 15859, 15865] and by John Macoun "in the old gravel pit" at Britannia in 1903 [MTMG



FIGURE 41. *Spiranthes cernua*, right inflorescence: moist scrape, Dolman Ridge, Mer Bleue Conservation Area, 2 September 1973; Centre inflorescence: moist scrape, Borthwick Ridge, Mer Bleue Conservation Area, 2 September 1980; whole plant: moist old-field habitat, Stony Swamp Conservation Area, 13 September 1980. The two inflorescences are drawn to the same scale.

8601]. References to *S. cernua* in the *Flora Ottawaensis* (Fletcher 1880, 1893) were likely based on James Fletcher's collection of *S. romanzoffiana* at "Lake Flora, Hull, P.Q." in 1877 that he mislabelled *S. cernua* [DAO 89679] (see *S. romanzoffiana* account).

That this species was not collected earlier suggests that it was very rare here before 1900. Indeed, only one additional site was reported up to 1917 (in 1909 [CAN 117012], Harrington 1917). It is likely that human alteration of the landscape in the 19th century enabled *S. cernua* to expand its range northward into this area and/or increase its numbers dramatically.

In the Arnprior area at the western edge of the District, *S. cernua* was unknown to Charles Macnamara (*circa* 1940*) in the first part of the 20th century. Photographs that Macnamara labelled *S. cernua* are clearly *S. romanzoffiana*. *Spiranthes cernua* is currently considered uncommon in the Arnprior area (Michael Runtz 1984, personal communication 1995).

SEASONAL DEVELOPMENT: In late 1994, we examined overwintering shoots in the Anderson Road colony described above. In 1995, we marked 15 randomly selected plants in this colony and observed them throughout the growing season, usually once a week during the more rapid stages of growth. These plants grew in the sun on the east-facing slope of the shallow ditch below a wire fence where they would be safe from mowing. We made additional observations on the other plants in the colony at the same times.

The above-ground seasonal development of the mature plant of *S. cernua* can be considered in terms of several distinct, consecutive processes with some temporal overlap, i.e., growth and decay of the basal leaves, growth of the flowering stem and cauline leaf, development of the inflorescence, appearance of new overwintering buds, and seed production and release.

Development of Basal Leaves

An unusual mid March thaw melted the snow sufficiently on the lip of the ditch to reveal the overwintering buds. They were about 1 cm high, some still a lanceoloid bud, others with two leaves opened to reveal a minute growing tip. By mid May, the two leaves were 2.5 - 3.5 cm long (almost their maximum length) and the central shoot had elongated slightly. By 4 June, two new leaves were growing rapidly from the centre and had become 5 - 10 cm long. On robust plants, there was an additional leaf about 1 cm long in the centre. Leaf growth had effectively stopped by 2 July when the two new leaves were 11 - 13 cm long and the inner leaf was 5 - 7 cm long. The original two leaves were yellow or brown. By 22 July, the two large leaves were turning yellow or brown on their outer halves or losing their tips, and the original two leaves had disappeared.

Development of the Flowering Stem and the Inflorescence

In the second week of July, the flowering stem and clasping cauline leaf appeared in the centre of the basal leaves and was 1.5 - 5 cm tall by 22 July. The flowering stem achieved its most rapid growth over the next two weeks, reaching 4 - 15 cm by 6 August. The basal leaves continued to decay. The cauline leaf near the base of the stem had grown to 2 - 6 cm, nearly its maximum length. The stem reached 7 - 17 cm on 13 August and its maximum of 13 - 19 cm on 20 August. The cauline leaf had achieved its greatest length of 3 - 7 cm by 28 August and on some plants was turning yellow.

On 20 August, the floral buds of most plants were quite distinct and arranged in three nearly vertical ranks independent of the rank of the ultimate mature inflorescence. About three-quarters of the flowers were open by 28 August and almost all by 3 September. By 13 September, half of the plants had brown flowers. The individual flowers lasted about two weeks or a little longer. Most inflorescences were four-ranked and the rest were three-ranked.

For the 156 flowering plants in the colony, the average height (for a 25 plant sample) was 20.4 (4.8) cm and the average number of flowers was 15 (5.7).

Overwintering Buds, Capsules and Seed Release

New overwintering buds were appearing beside the flowering plants by 13 September. Almost all flowering plants produced capsules, which expanded during the next month and then released seed in October.

Non-flowering Plants

Of the 15 plants originally selected, four did not produce flowers. The initial development of the non-flowering plants was similar to that of the flowering plants except that the leaves were shorter, their maximum lengths being 6.5 - 7.5 cm. There was usually a total of four leaves on the more robust or mature non-flowering plants and two or three on smaller plants. Most of the non-flowering plants had produced new overwintering buds by 3 September, at least 10 days before the flowering plants. Similar early bud appearance was also noted on a flowering plant that had only one flower and on another that had been accidentally decapitated between 6 August and 13 August, probably as a result of mowing nearby.

The Effects of Mowing

The broad, flat part of the ditch was mowed in late June and again in the first week of August. The 17 flowering plants in this part of the ditch were unusually short, 10.8 (2.3) cm, with few flowers, 7.3 (4.6). Although the flowers opened at the same time as the rest of the colony, only a few had brownish flowers by 13 September compared with about 50% for the marked plants discussed above. The stems of some of these small plants were deformed, in some cases to the extent that they were horizontal on the ground.

The Effects of Shade

On a section of the east-facing slope that was in the open but lightly shaded by nearby bushes for most of the day, there were three flowering and several non-flowering plants. The flowering plants developed more slowly, flowered later, were taller, more slender, and had longer, narrower leaves and fewer, more widely-spaced flowers than those of the rest of the colony. The flowers were arranged in a single rank. The plants flowered between 13 September and 1 October, about two weeks later than the rest. (Some of their lower flowers were brown by the latter date.) They were 21, 26 and 27 cm tall and had 9, 10 and 12 flowers.

Similar effects of shade were expressed in the recent plants on the Borthwick Ridge in the aspen-birch-tamarack-maple-alder habitat (see Long-lived Colonies above). In 1994, the average height of 33 plants there was 28.3 (4.3) cm and the average number of flowers was 14.4 (5.7). Half of the inflorescences were four-ranked and half were single-ranked.

The Effects of a Cooler Season

The summer of 1995 was one of the hottest and driest on record (with very little rain after a record-breaking deluge on 2 June). As a result, seasonal development of the leaves was earlier than usual. By comparison, the spring of 1996 was cooler than normal and the summer until August was slightly cooler than normal. August temperatures were closer to normal. Overall precipitation was slightly below normal. Development of the leaves in 1996 was slower than in 1995. For example, in late July the two (or three) longer basal leaves were still green with very little dying-off at the tips. Some of the original pairs of basal leaves remained green, while others were yellow or had turned brown. At anthesis, the original two basal leaves had disappeared but the two or three more recent leaves, as well as the cauline leaf, were still green or at most tinged with yellow. By the time the flowers were brown, these leaves remained mostly green but the yellowish component was stronger and the ends were brown or had died off. The cauline leaf remained green. Timing of the emergence and development of the flowering stalk was similar to that in 1995.

In 1996, there were 622 flowering plants with an average height (for a 50 plant sample) of 19.5 (5.7) cm.

The Amount of Repeat Flowering from One Year to the Next

Of the 16 plants marked and followed in 1995, five in the open sun flowered in both 1995 and 1996 as did one of the three in the shade. However, all of the monitored flowering stalks were bitten off in mid August before the flowers opened. Perhaps our handling of the plants had left scents that attracted the selective attentions of a herbivore.

Throughout the summer, new seedlings appeared where there were none before. It is our impression that individual plants have a life span of only a few years and the colony is maintained by seeding.

The Effects of Not Mowing

In 1996, the broad flat section of the ditch was not mowed in August at our request and with the gracious cooperation of Regional Municipality of Ottawa-Carleton staff (Craig Huff, Urban Forester; Richard Scott, Supervisor; and Bob McNeil). The plants in the ditch followed the normal patterns of development of the rest of the colony and did not show any distortion of form. The average height of these plants was consistent with that of the rest of the colony. Instead of the 17 flowering plants in 1995, there were many hundreds. The difference in the total count of the colony, from 156 flowering plants in 1995 to 622 in 1996, was largely due to the greater number in the ditch.

SPIRALITY: *Spiranthes* species are often classified as single-ranked or multi-ranked. For example, *S. casei* is single-ranked and *S. cernua* is usually multi-ranked. However, these terms refer to different concepts that are not always mutually exclusive, sometimes causing some confusion in the description of *S. cernua*. One concept, single-ranking, describes the order in which the flowers developed on the rachis, while the other, multi-ranking, describes apparent patterns of flowers that the human eye perceives.

In *Spiranthes* inflorescences there is always a single fundamental spiral marking the positions of successively formed flowers. (This spiral is equally likely to rise to the left or to the right with the flowers facing to the right or to the left, respectively.) If the spiral is not too compressed, it is easily seen and the plant is classified as single-ranked. Otherwise, the eye is more likely to discern a set of parallel ranks of flowers crossing the fundamental spiral. These ranks may be vertical or may spiral up the inflorescence at a moderate angle to the axis. Plants with this appearance are termed multi-ranked. However, the fundamental spiral is still present and may be apparent in four-ranked plants.

Sheviak (1982) has argued that the use of rank as a character has resulted in considerable confusion in the determination of some *S. cernua* plants, partly because it recognizes only the extreme limits of single- and multi-ranking instead of the continuous range of possible arrangements. In addition, he finds that this character can be inconstant. He proposes that the phyllotaxy should be used instead of the rank. The phyllotaxy is the ratio of the number of turns of the fundamental spiral to the number of flowers encountered along that spiral, counting from a given flower to the next one directly above it.

However, we believe that the phyllotaxy also presents problems in its application to real plants. It still

does not adequately describe the continuous character of possible spiral behaviour from one plant to another because it uses the idealization of integral numbers of ranks, at least as it is often used. Further, it is applied to the structure that the human eye perceives rather than to the actual structure of the inflorescence.

For a more detailed analysis and understanding, it is useful to consider the concept of the divergence, which is simply the angle between two successive flowers as seen along the axis of the inflorescence. The divergence is closely related to the phyllotaxy but the former permits an explicit account of the continuous character of the spirality and does not depend on perception. It can thus be used to describe some of the more subtle effects that can arise.

In the Ottawa District, *S. cernua* is commonly three- or four-ranked. In the four-ranked plants, the ranks are usually quite vertical, reflecting divergence angles of about 88° - 92° (middle inflorescence in Figure). Some other four-ranked plants have divergences up to 103° , in which case the ranks twist in the same direction as the fundamental spiral. A few plants have divergences around 86° and the ranks twist in the opposite direction. The four-ranked inflorescences have 13 - 19 flowers with an average spacing along the rachis of 3.8 (0.3) mm. If the fundamental spiral is lax, the inflorescence may appear to be simultaneously single-ranked and four-ranked.

Plants with divergences larger than 103° appear three-ranked. A few *S. cernua* have a divergence of 120° and display three vertical ranks. Most, however, have angles in the range of about 103° - 115° , in which case the ranks spiral in the opposite direction to the fundamental spiral (plant on right in Figure).

In the occasional plant with a divergence greater than 120° , the two types of spirals turn in the same direction. Three-ranked plants have about 15 - 40 flowers with a spacing of 3.3 (0.1) mm.

Inflorescences with a divergence of about 107° can show four ranks simultaneously with the usual three ranks. However, the four ranks involve flowers in every other turn of the fundamental spiral instead of in adjacent turns.

A few of the *S. cernua* colonies on the open sands of the southeast contain some single-ranked plants. They have divergences of about 60° - 80° , corresponding to six or five flowers, respectively, per turn of the fundamental spiral (left inflorescence in Figure and photograph in Reddoch and Reddoch 1974). Such plants have 9 - 14 flowers with an average spacing of 4.4 (0.1) mm. These plants may be part of single-ranked triploid populations centred in the Eastern Townships of Quebec, New England and adjacent New York (Catling 1980; Sheviak 1982, Figure 18a-d).

Often, flowers near the top or bottom of an inflorescence are not as regularly arranged as those near the centre. Some inflorescences are irregular throughout.

Sheviak (1982) has noted that single-ranked plants tend to have fewer flowers than others. The flower counts given above support this result and show a highly significant correlation, $r = 0.62$ for 57 plants, between divergence and flower number. The single-ranked plants have the fewest flowers while the three-ranked plants have the most.

A sampling of several local colonies has shown that the buds develop in a three-ranked formation regardless of the ranking of the open flowers.

Spiranthes lacera (Rafinesque) Rafinesque var. *lacera*

Northern Slender Ladies'-tresses

Spiranthe découpée

SYNONYM: *Spiranthes gracilis* (Bigelow) Beck (in part)

This is an inconspicuous orchid, easily mistaken at first glance for a grass. On closer inspection, it is clearly an orchid and may be distinguished from our other *Spiranthes* by the greenish lip and the small, ovate, basal leaves.

DESCRIPTION

Height: 12 (21 - 35) 46 cm [206 plants].

Flowers: 9 (13 - 25) 35 [77 plants]; white with centre of lip yellowish green, light green or greyish green inside and outside or mainly along the veins; in a single rank with almost no spiral or up to 3 loose turns, occasionally to 5 turns, rising to the right or left; fragrance usually marked, sweet, floral, occasionally spicy.

Leaves: 3 - 5 in a basal rosette with 0 - 2 remaining at anthesis; and 1, cauline, near base; non-flowering plants with 1 - 5 leaves.

Overwintering State: a rosette of leaves surrounding a central bud (rarely two or three rosettes), appearing above ground beside the current year's stem in late August to mid September shortly after anthesis

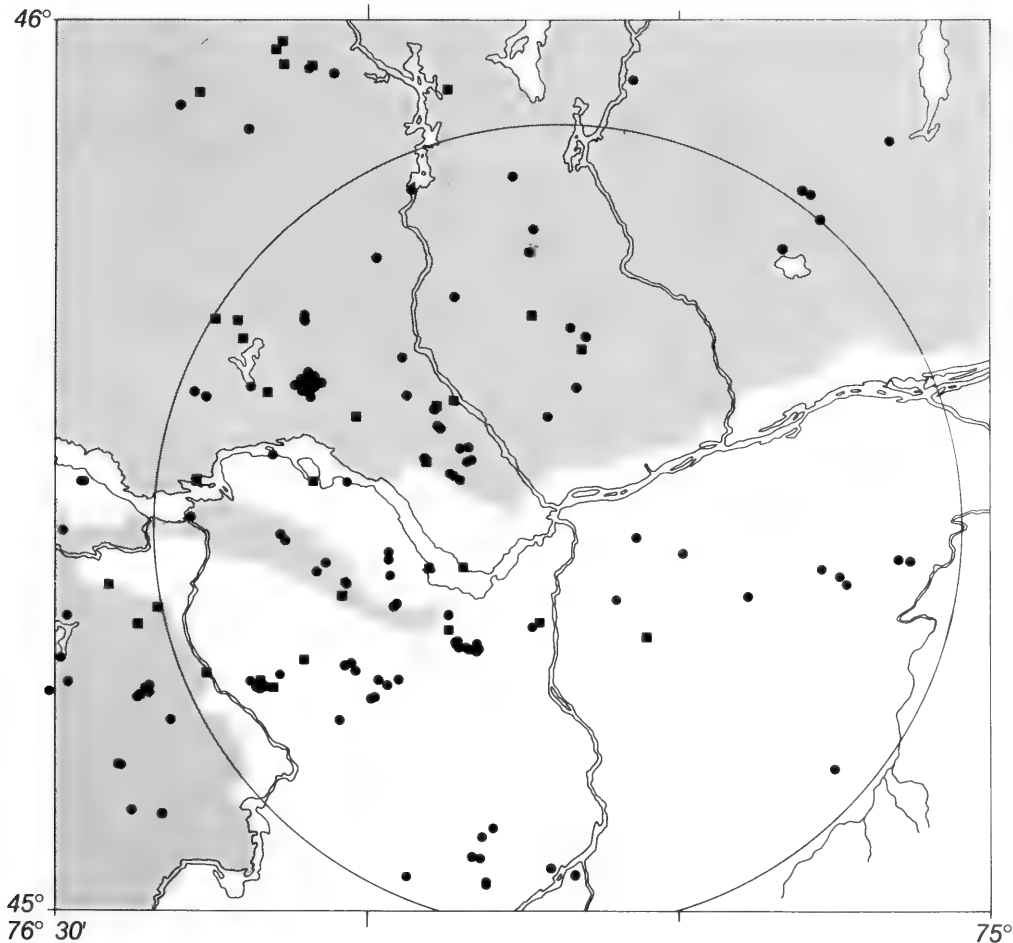
and developing to almost ultimate size and number of leaves before winter; new rosettes appearing earlier and developing further on decapitated plants.

Capsules: brown, ellipsoid to spheroid, typically 0.3 x 0.2 cm, slightly ascending (see Figure 1d); yield generally over 50%, averaging 85% [26 plants].

Seeds: light brown, released in early to mid August, about two weeks after the flowers have turned brown.

BLOOMING PERIOD: 1 July (13 July - 12 August) 7 September [82 records].

COLONY SIZES: 1 - 200 flowering plants, fewer than 30 in 87% of colonies; one exceptional colony with 1721 flowering plants (see Long-lived Colonies



Spiranthes lacera var. *lacera*: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record. The Canadian Shield is shaded.

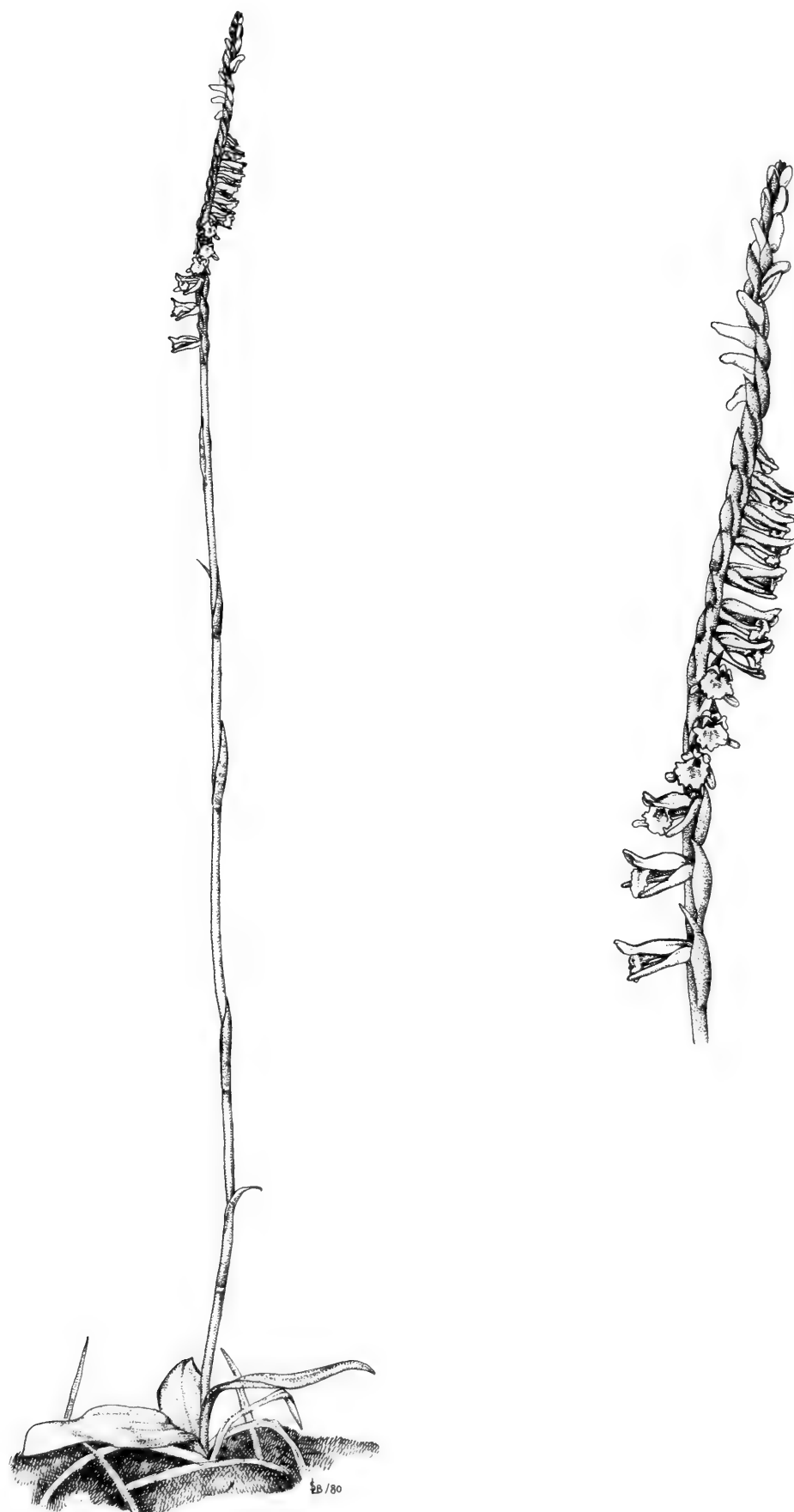


FIGURE 42. *Spiranthes lacera* var. *lacera*, open mixed woods, Gatineau Park, Quebec, 9 August 1980.

below) [137 colonies]; flowering plants occurring mostly as scattered individuals, occasionally 2 or 3 together.

DISTRIBUTION: The Ottawa District is near the northern edge of the range of *S. lacera* var. *lacera*. This variety extends over much of the Mixed Forest Region and the northern part of the Deciduous Forest Region (Luer 1975). Within the District, this species is widespread, with concentrations along the Eardley-Masham Road in Gatineau Park, in the Stony Swamp Conservation Area and in The Burnt Lands Alvar.

HABITATS: This orchid frequents areas of dry to moist, shallow to deep sand over almost any rock type, acidic or basic. Colonies are found in open, sandy or rocky, deciduous or coniferous woods, in pine plantations, in sandy or rocky old-fields and on open Precambrian knolls. Rarely, a plant or two becomes established in a coniferous swamp or on a semi-shaded river shore. Plants generally occur close to trees and shrubs, even in old-fields. In most situations, there is little or no competing vegetation.

LONG-LIVED COLONIES: Where habitats are relatively stable, colonies of *S. lacera* can endure for several decades at least.

In 1968, 140 flowering plants were scattered around outcrops of calc gneiss bedrock (Hogarth 1970) among young White Birch, Sugar Maple, Red Oak and Eastern White Pine in Gatineau Park. The colony continues to carry on, although in reduced numbers, where the canopy is still fairly open.

In the Larose Forest, there were 1721 flowering plants of *S. lacera* in 1969, growing in deep sand under the high canopy of a well-trimmed, 40-year-old Scots Pine plantation. The ground cover was mainly a thick layer of pine needles with a few

patches of *Polytrichum* mosses under Bracken (*Pteridium aquilinum*). Now, a few hundred flowering plants remain in the areas that have not become overgrown nor been cleared for a picnic site. *Cypripedium acaule* is a constant companion here.

EARLY HISTORY: *Spiranthes lacera* was first recorded in the Ottawa District in 1887 (Fletcher 1888) and was described as "very rare" in 1893 (Fletcher 1893). Until the second decade of this century, Blueberry Point near Aylmer, Quebec, was one of the few known localities for this species. There, it was collected from sandstone openings among Eastern White Pines [CAN 117018, -19, -20] and on a hummock at the edge of a swamp (Fletcher 1893). *Cypripedium acaule* was also collected at Blueberry Point. The construction of the Wychwood subdivision destroyed much of the natural habitat and put an end to Ottawa Field-Naturalists' Club excursions there (Groh 1910; Reddoch 1979b).

SEASONAL DEVELOPMENT - SUMMARY: Before and during anthesis, the basal leaves of the current year's plant die. Shortly after the flowers die, one, two or three (rarely zero) new shoots appear above ground beside the plant. Usually only one shoot survives; it develops into a rosette of almost full-size leaves surrounding a central bud before winter. Non-flowering plants produce new shoots according to a similar schedule.

In the spring, the last leaf unfurls and the leaves complete their growth. Some of the outer leaves begin to turn yellow in June.

The plant may produce a flowering stalk or remain as a non-flowering plant. If it is going to flower, the flowering stalk rises from the centre of the rosette in June and expands throughout June and July until flowering. In the two weeks after the flowers die, the capsules ripen and release their seed.

Spiranthes lucida (H. H. Eaton) Ames

Shining Ladies'-tresses

Spiranthe lustrée

This is the smallest, the earliest blooming and the least abundant of our *Spiranthes*. It can be recognized by the bright yellow of the lip and the late June to early July blooming period.

DESCRIPTION:

Height: 11 (14 - 20) 28 cm [66 plants].

Flowers: 5 (8 - 16) 21 [56 plants]; white with lip yellow to vivid yellow, above and below, often with greyish green to dark green as a wash in centre or as three broad parallel stripes or, when faint, following the veins; nodding or horizontal, occasionally ascending; in 3 ranks or occasionally 4; fragrance rich and sweet or spicy or undetectable.

Leaves: 3 - 6, typically 4 - 5, basal, shiny, mostly present at anthesis; 1 - 5 on non-flowering plants.

Overwintering State: a rosette of 3 greyish green leaves, appearing above ground beside the current year's plant in early summer before anthesis (as shown in Plate 80 of Correll (1950)); in October, leaves 1 - 3 cm long, surrounding a narrowly conical bud 0.5 cm tall, usually accompanied by a last fading leaf of the current year's plant.

Capsules: light brown to brown, ellipsoid, typically 0.8 x 0.35 cm, ascending.

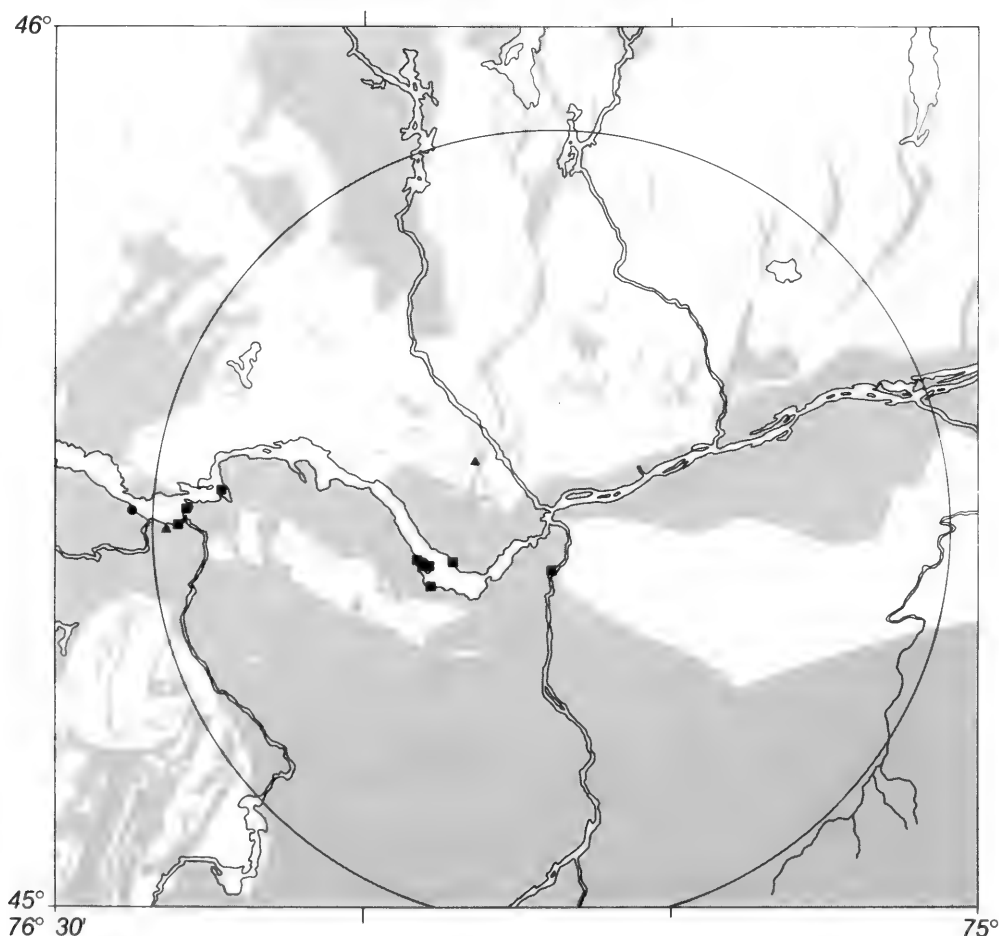
Seeds: greyish brown.

BLOOMING PERIOD: 19 June (25 June - 7 July) 11 July [19 records].

COLONY SIZES: 3 - 90 flowering plants [13 colonies], as scattered individuals or in clumps of 1 - 3 flowering plants, accompanied at anthesis by new shoots (see Overwintering State above) and occasionally non-flowering plants.

CURRENT STATUS: rare in the Province of Quebec (Bouchard et al. 1983), rare in the Ottawa District.

DISTRIBUTION: The Ottawa District is at the northern limit of the range of this lower Great Lakes - Atlantic Coast species. It is mainly a plant of the Mixed Forest Region and the adjacent Deciduous



Spiranthes lucida: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record, ▲ = literature reference. Major areas underlain by calcareous rock (marble and limestone) are shaded.



FIGURE 43. *Spiranthes lucida*, Ottawa River shore, Innis Point, City of Kanata, Regional Municipality of Ottawa-Carleton, Ontario, 27 June 1978.

Forest Region. Within the District, *S. lucida* is essentially restricted to the shores of the Ottawa River and some of its tributaries in areas of limestone bedrock on the Lowlands and marble on the Shield. Whiting and Catling (1986) have mapped two additional collections in the District from the Madawaska and Mississippi Rivers.

HABITAT: Colonies are confined to rocky or sandy shores that are scrubbed annually by ice and flood waters to a distance inland of up to 15 m. Plants usually are within a few metres of the water's edge, among low sedges, rushes and grasses, in the wet sand that has lodged around stones and boulders or in crevices in the bedrock pavement. Some years, high water covers the plants from time to time. Additional accompanying plants include Meadow Spikemoss (*Selaginella apoda*), Marsh Fern (*Thelypteris palustris*), Wild Iris (*Iris versicolor*), Silverweed (*Potentilla anserina*), Shrubby Cinquefoil (*P. fruticosa*), Kalm's St. John's-wort (*Hypericum kalmianum*), Purple Loosestrife (*Lythrum salicaria*), Indian Hemp (*Apocynum cannabinum*) and, occasionally, *Platanthera flava*.

In 1912, Charles Macnamara discovered and photographed two flowering plants of *S. lucida* in a field close to the Ottawa River near Arnprior, Ontario. Here, the plants grew in tall grasses and sedges on a wet bank beside a small stream. He followed the colony for at least three years (Macnamara *circa* 1940*; Reddoch 1981c).

Along the Mississippi River just south of the Study Area, *S. lucida* occupies the eroded rocky or sandy bank adjacent to the aquatic zone. Companion species there include Meadow Spikemoss, Arrow-grass (*Triglochin maritimum*), sedges (*Carex* spp.), Golden Sedge (*Carex aurea*), Twig-rush (*Cladium mariscoides*), Wild Iris, Tall Meadow-rue (*Thalictrum polygamum*), Grass-of-Parnassus (*Parnassia glauca*), Purple Loosestrife, Marsh Bellflower (*Campanula aparinoides*),

Cardinal-flower (*Lobelia cardinalis*) and Kalm's Lobelia (*L. kalmii*) (Patricia Rothschild, personal communication 1984; Lemky and Keddy 1988). Purple Loosestrife is currently being kept under control by hand weeding (Patricia Rothschild, personal communication 1996).

LOCAL HISTORY: *Spiranthes lucida* was first noted in the Ottawa District in 1905. A single plant was discovered and collected on the Ottawa River shore below the Victoria Hotel at Aylmer, Quebec, by W. Hague Harrington ([CAN 117016], Harrington 1917). In 1908, a second plant was found "by the brookside near Old Chelsea" (Harrington 1917). These two plants are the only records from the Quebec part of the District.

Colonies at Shirley's Bay - Innis Point in the western Greenbelt have been known for almost 50 years. They are scattered along the Ottawa River from the sandy beaches of Shirley's Bay to the limestone pavements of Innis Point and beyond, a distance of several kilometres. Along this shore, the colonies vary in size and location from year to year. Access to this property is restricted by the Department of National Defence, thus affording some protection to *S. lucida* and the other rare plants of the Innis Point shoreline (White 1979).

SEASONAL DEVELOPMENT - SUMMARY

The shoot for the next year's plant appears above ground in late June beside the current year's plant. It comprises three leaves and a growing tip which continue to expand through the growing season. At the end of the season, the leaves are as long as 3 cm and the growing tip has become a partially unfurled leaf up to 1.6 cm long. At this time, the leaves of the current year's plant, some of which remained green into September, are now brown and some have disappeared.

The next spring, the new leaves continue to expand to full size. The flowering stalk extends from the centre of the basal leaves during the month of June.

Spiranthes romanzoffiana Chamisso

Hooded Ladies'-tresses

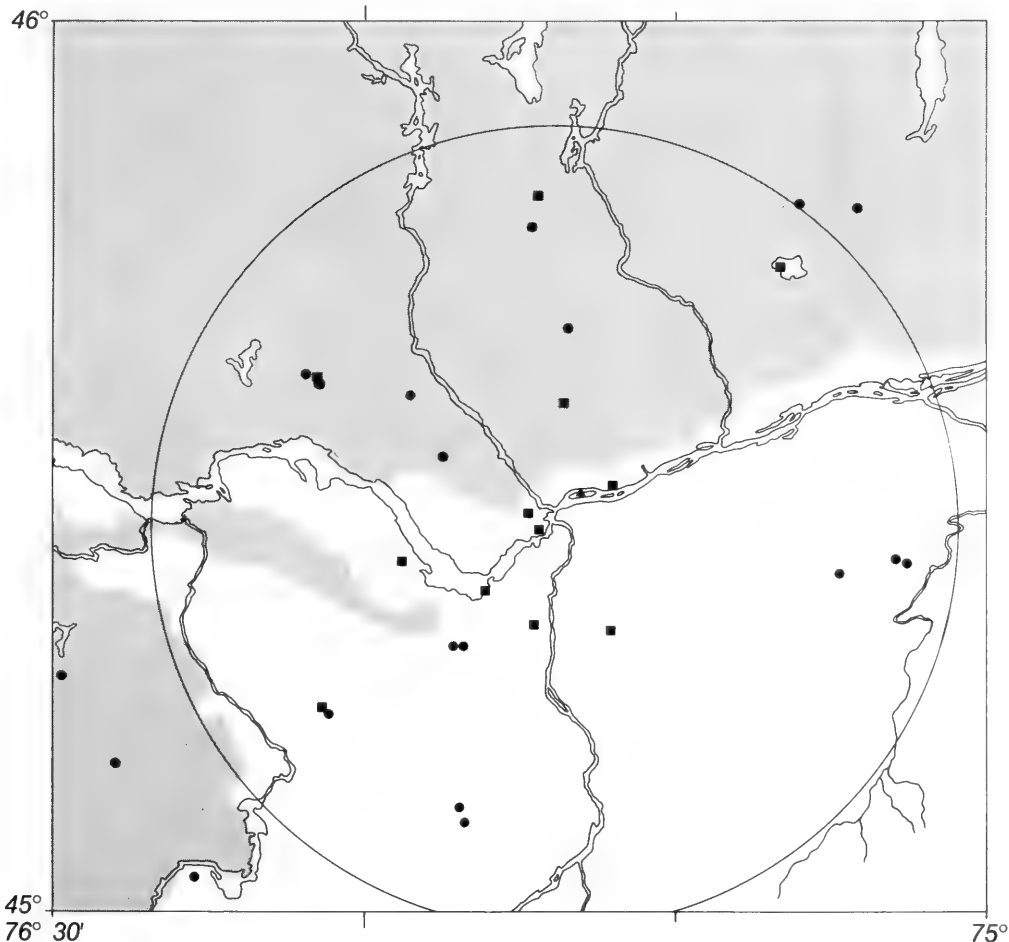
Spiranthe de Romanzoff

This *Spiranthes* is encountered infrequently in the District. Its colonies are usually small and often short-lived. *Spiranthes romanzoffiana* is sometimes mistaken for *S. cernua* but can be recognized by its ascending, hooded, creamy white flowers and by its lip, which has a constriction where it emerges from the hood.

DESCRIPTION

Height: 9 (18 - 33) 53 cm [64 plants].
Flowers: 4 (9 - 29) 45 [58 plants]; white to yellowish white with light green at the base of the sepals, lip yellowish white, occasionally with greenish white at its centre; usually arranged in 3 slightly spiral ranks to right or left, occasionally in 4 ranks or irregular; fragrance strong and rich to light vanilla.
Leaves: 3 - 4, basal, withering to leave 2 - 3 at anthesis; and 1, cauline near base, sometimes bract-like; 4 on non-flowering plants.
Overwintering State: a greyish green, lanceoloid shoot, 1 cm above ground beside the current year's stem, appearing by early September; from near Hatley, Quebec, Mousley (1924a, b) reported that the new shoot was present at the base of the flowering stem by early August and the first pair of root

buds appeared in early October; sometimes there were two shoots and, on one occasion, three, each with two root buds; 1 - 2 and sometimes 4 or more additional fleshy roots were produced the following spring.
Capsules: light brown to brown, ellipsoid, typically 0.8 x 0.4 cm, ascending.
Seeds: light brown, released by mid September.
BLOOMING PERIOD: 4 July (20 July - 19 August) 15 September [33 records].
COLONY SIZES: 1 - 15 flowering plants, 3 or fewer in 60% of colonies [24 colonies], as scattered individuals or rarely as a loose group.
DISTRIBUTION: The Ottawa District is in the south-eastern part of the North American range of this transcontinental species. It occurs in the Montane,



Spiranthes romanzoffiana: ■ = herbarium specimen, ● = Native Orchid Location Survey sight record, ▲ = literature reference. The Canadian Shield is shaded.

Boreal and Mixed Forest Regions. *Spiranthes romanzoffiana* is scattered thinly across the District.

HABITATS: This species has been found in a variety of habitats, some wet and some moist.

Small colonies have been encountered on the wet floors of almost every calcareous sedge fen and in some semi-open swamps. Other plants occasionally turn up in open or partially shaded, moist, sandy seepage areas and the edges of lakes, streams, beaver ponds, fens and swamps.

In addition to the above typical habitats, *S. romanzoffiana* plants appear from time to time in moist, partially shaded, sandy forest edges. In 1973 and 1974, in the Larose Forest, a clump of seven flowering plants grew in well-drained sand several tree-rows in from the edge of a 45-year-old Red Pine plantation. Another flowering plant was in a similar situation across the road. In another part of the forest two decades later, a single plant was in bloom at the edge of a Trembling Aspen - White Birch woodland beside a forest track adjacent to another Red Pine plantation. In the former location, *S. romanzoffiana* was accompanied by a large colony of *Malaxis unifolia* on the pine-needle covered ground among a few stalks of Bracken (*Pteridium aquilinum*). At the latter site, Bracken, Wild Lily-of-the-valley (*Maianthemum canadense*), Dewberry (*Rubus hispidus*), One-flowered Wintergreen (*Moneses uniflora*) and *Polytrichum* mosses were prominent accompanying plants.

At the Stony Swamp Conservation Area in the western Greenbelt in the early 1980s, a few plants of *S. romanzoffiana* were scattered among Bracken on a low ridge at the edge of an Eastern White Pine - Red Maple woodland. (One of these plants is the subject of the Figure.) They were adjacent to an open, moist

area of exposed sandstone bedrock that is home to a long-established mixed colony of *S. casei* and *S. cernua*. In a drier part of the same opening are scattered plants of *S. casei* and *S. lacera*.

Spiranthes romanzoffiana does not form large colonies as does *S. cernua*.

EARLY HISTORY: *Spiranthes romanzoffiana* was first collected in the District in 1877 at "Lake Flora, Hull, P.Q." by James Fletcher. This collection of two plants [DAO 89679] was identified by the collector as *S. cernua* and recorded as such in both versions of his *Flora Ottawaensis* (1880, 1893). It was annotated by Paul Catling as *S. romanzoffiana* in 1973. Lake Flora was a small pond on l'Ile de Hull (Nagy 1974) that is now Parc Fontaine. *Spiranthes romanzoffiana*, along with *Calopogon tuberosus* and *Pogonia ophioglossoides* (Fletcher 1893), likely grew on a sedge fen mat surrounding the pond. Other orchids in this calcareous peatland were *Corallorhiza trifida* (Macoun circa 1911*), *Cypripedium acaule* and *C. parviflorum* (Fletcher 1893).

The first recognized discovery of *S. romanzoffiana* came in 1890 (Fletcher 1891). William Scott collected this species at East Templeton, Quebec (Fletcher, Whyte, and Scott 1891; Fletcher, Scott, and Cowley 1892; collections at CAN, DAO, TRT). The 1892 authors reported that "W. Scott found *Spiranthes romanzoffiana* in profusion in a hayfield close to the East Templeton wharf, and between the wharf and the lightkeeper's house". The 1891 authors also mentioned that Robert B. Whyte had found the same species a short while later on Kettle Island, nearby in the Ottawa River; however, Fletcher (1893) included only the first location in his *Flora Ottawaensis*.



FIGURE 44. *Spiranthes romanzoffiana*, edge of mixed forest, Stony Swamp Conservation Area, Regional Municipality of Ottawa-Carleton, Ontario, 22 July 1979.

Possible Additional Species and Hybrids

Three orchid species have been discovered in recent years not far from the Ottawa District. Thus these species in particular should be watched for.

Corallorhiza odontorhiza: This species of the Deciduous Forest Region has been discovered 150 km southwest of the District near Trenton, Ontario (Brownell et al. 1994) and 80 km east of the District near the mouth of the Ottawa River (lac des Deux-Montagnes) in Quebec (Sabourin 1993).

Listera convallarioides: The closest known locations for this eastern Boreal Forest, Mixed Forest and Montane Forest species are both 90 km from the Ottawa District: northwest in the Ottawa Valley near Petawawa, Ontario (Whiting and Catling 1986) and northeast in the Laurentian Mountains north of Montreal, Quebec (Sabourin 1993). The Petawawa colony consists of a hundred or so plants but only a few plants flower each year (Grant Bickel, personal communication 1996).

Spiranthes ochroleuca: This species of the Deciduous Forest has been found 90 km southwest of the Ottawa District in Frontenac County, the only record in Eastern Ontario (Whiting and Catling 1986). It has not been recorded in Quebec (Sabourin 1993, personal communication 1995).

Homoya (1993) included a disjunct dot in the Ottawa District on his distribution map for this species; however, he informed us (personal communication 1995) that this dot was the result of a production error.

Hybrids: There are several species in the Ottawa District that have produced hybrids elsewhere in their ranges. These hybrids are *Platanthera* x *vossii* Case (*P. blephariglottis* var. *blephariglottis* x *P. clavellata* var. *clavellata*), *P.* x *keenanii* P. M. Brown (*P. lacera* x *P. grandiflora*), *P.* x *andrewsii* (Niles) Luer (*P. lacera* x *P. psycodes*) and *Spiranthes* x *simpsonii* Catling and Sheviak (*S. lacera* var. *lacera* x *S. romanzoffiana*).

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Appendix 1: Summary of Lists of Orchids of the Ottawa District and Adjacent Areas

1861 = herbarium specimens of John Kerr McMorine at QK and DAO (dated 1861 – 1867)
1867 = *List of Plants collected by Mr. B. Billings in the vicinity of the City of Ottawa, during the Summer of 1866* (Billings 1867)
1880 = *Flora Ottawaensis* (Fletcher 1880)
1893 = *Flora Ottawaensis* (Fletcher 1893)
1911 = *The Ottawa Flora* (Macoun circa 1911*)
1958 = *Checklist of Plants of the Ottawa District* (Gillett 1958)
1977 = *Native Orchid Location Survey* (Reddoch 1977b); *Checklist of Vascular Plants of the Ottawa-Hull Region, Canada* (Gillett and White 1978)
1940 = *Some Orchids of Eastern North America Photographed by Charles Macnamara* (Macnamara circa 1940*)
1984 = *Orchids of the Arnprior Area* (Runtz 1984)

	OTTAWA DISTRICT							ARNPRIOR	
	1861	1867	1880	1893	1911	1958	1977	1940	1984
<i>Amerorchis rotundifolia</i>	-	-	X	X	X	X	X	-	-
<i>Aplectrum hyemale</i>	-	-	-	X	X	X	X	-	-
<i>Arethusa bulbosa</i>	-	-	-	X	X	X	X	-	X
<i>Calopogon tuberosus</i>	X	X	X	X	X	X	X	-	X
<i>Calypso bulbosa</i>	-	-	X	X	X	X	X	X	X
<i>Coeloglossum viride</i>	X	-	X	X	X	X	X	X	X
<i>Corallorhiza maculata</i>	X	-	X	X	X	X	X	-	X
<i>Corallorhiza striata</i>	X	-	-	X	X	X	X	X	X
<i>Corallorhiza trifida</i>	-	-	X	X	X	X	X	X	X
<i>Cypripedium acaule</i>	X	-	X	X	X	X	X	X	X
<i>Cypripedium arietinum</i>	-	-	-	X	X	X	X	X	X
<i>Cypripedium parviflorum</i>	X	X	X	X	X	X	X	X	X
<i>Cypripedium reginae</i>	X	X	X	X	X	X	X	X	X
<i>Epipactis helleborine</i>	-	-	-	-	-	X	X	-	X
<i>Galearis spectabilis</i>	-	X	X	X	X	X	X	X	X
<i>Goodyera pubescens</i>	-	-	-	X	X	X	X	-	-
<i>Goodyera repens</i>	X	-	X	X	X	X	X	X	X
<i>Goodyera tessellata</i>	-	-	-	-	-	X	X	@	X
<i>Liparis loeselii</i>	-	-	X	X	X	X	X	X	X
<i>Listera auriculata</i>	-	-	-	-	-	-	X	-	-
<i>Listera australis</i>	-	-	-	-	X	-	X	-	-
<i>Listera cordata</i>	-	-	-	-	X	X	X	-	X
<i>Malaxis monophylla</i>	-	-	X	X	X	X	X	X	X
<i>Malaxis unifolia</i>	X	-	X	X	X	X	X	X	X
<i>Platanthera blephariglottis</i>	-	-	X	X	X	X	X	-	-
<i>Platanthera clavellata</i>	-	-	X	X	X	X	X	-	-
<i>Platanthera dilatata</i>	-	X	X	X	X	X	X	X	X
<i>Platanthera flava</i>	-	-	-	X	X	X	X	-	-
<i>Platanthera grandiflora</i>	-	-	-	X	X	X	X	-	-
<i>Platanthera hookeri</i>	-	X	X	X	X	X	X	X	X
<i>Platanthera huronensis</i>	-	-	-	-	-	-	-	-	-
<i>Platanthera hyperborea</i>	X	X	X	X	X	X	X	X	X
<i>Platanthera lacera</i>	-	-	-	-	-	X	X	-	-
<i>Platanthera leucophaea</i>	-	-	-	-	-	-	X	-	-
<i>Platanthera macrophylla</i>	-	-	-	-	-	#	-	-	-
<i>Platanthera obtusata</i>	-	-	-	-	X	X	X	-	X
<i>Platanthera orbiculata</i>	X	-	X	X	X	X	X	X	X
<i>Platanthera psycodes</i>	X	X	X	X	X	X	X	X	X
<i>Pogonia ophioglossoides</i>	X	-	X	X	X	X	X	-	X
<i>Spiranthes casei</i>	-	-	-	-	-	-	X	-	-
<i>Spiranthes cernua</i>	-	-	-	-	X	X	X	-	X
<i>Spiranthes lacera</i>	-	-	-	X	X	X	X	X	X
<i>Spiranthes lucida</i>	-	-	-	-	-	X	X	X	X
<i>Spiranthes romanzoffiana</i>	-	-	*	X	X	X	X	*	X
Total species:	13	8	23	31	35	38	42	22	30

@ discussed as *Goodyera pubescens* but photograph shows *G. tessellata*
#presumably a mistaken identification
*erroneously identified as *S. cernua* (see species account).

Appendix 2: Significant Vegetation of Six Calcareous Sedge Fens

Two of the Lowland fens, the Richmond Fen and the Phragmites Fen, are components of the 20 km² palustrine wetlands complex adjacent to the Jock River. A third fen, the Manion Corners Long Swamp Fen, is a patterned fen of about 20 ha area in a 15 km² peatland (Reddoch 1978a). It is a patterned fen that has evolved in a saddle between the Mississippi River and Rideau River watersheds. The pattern is an array of sedge fen lenses aligned across the direction of water flow and separated from one another by treed peat ridges. The fourth fen is the Mud Pond Fen, a partially floating fen behind an ice-pushup ridge or ancient beach at the edge of a small, marl-bottomed pond surrounded by swamp.

Two fens on the Shield have formed in long, narrow bays of small lakes, the Quebec fen near Poltimore, and the White Lake Fen adjacent to the lake in Renfrew County named for its marl-covered bottom.

This list is an update of previously published lists (Reddoch 1979a, 1984, 1989).

RICH = Richmond Fen, PHRA = Phragmites Fen, L.S. = Manion Corners Long Swamp Fen, M.P. = Mud Pond Fen, POLT = Fen near Poltimore, W.L. = White Lake Fen.

	RICH	PHRA	L.S.	M.P.	POLT	W.L.
Vascular Plants[#]						
<i>Scheuchzeria palustris</i>	X	X	-	-	-	-
<i>Triglochin maritimum</i>	X	X	X	-	-	X
<i>Triglochin palustre</i> [@]	-	-	-	-	-	X
<i>Bromus ciliatus</i>	X	X	X	-	-	-
<i>Calamagrostis stricta</i> ssp. <i>stricta</i> ^{&}	-	-	-	-	-	X
<i>Muhlenbergia glomerata</i>	X	X	X	X	X	X
<i>Phragmites communis</i>	X	X	-	X	-	X
<i>Carex chordorrhiza</i>	-	-	X	-	X	-
<i>Carex diandra</i>	X	-	X	X	X	-
<i>Carex disperma</i>	-	X	X	X	X	-
<i>Carex exilis</i>	X	-	X	-	-	-
<i>Carex lasiocarpa</i>	X	X	X	X	X	X
<i>Carex limosa</i>	X	X	X	X	X	X
<i>Carex livida</i>	X	X	X	-	-	-
<i>Carex pauciflora</i>	-	-	-	-	X	-
<i>Carex paupercula</i> = <i>C. magellanica</i>	-	-	X	X	X	X
<i>Carex prairea</i>	-	-	X	-	X	-
<i>Carex tenuiflora</i>	-	-	X	-	X	-
<i>Carex trisperma</i>	-	-	X	-	X	-
<i>Carex vaginata</i>	-	-	X	-	-	-
<i>Cladium mariscoides</i>	X	X	-	X	-	X
<i>Dulichium arundinaceum</i>	X	-	-	-	X	-
<i>Eleocharis elliptica</i> [*]	-	-	X	-	-	-
<i>Eriophorum viridi-carinatum</i>	-	X	X	X	X	X
<i>Rhynchospora alba</i>	X	X	X	X	-	X
<i>Rhynchospora capillacea</i>	-	-	-	-	-	X
<i>Scirpus acutus</i>	-	-	-	-	-	X
<i>Scirpus hudsonianus</i>	X	X	X	X	X	X
<i>Smilacina trifolia</i>	-	X	X	X	X	X
<i>Amerorchis rotundifolia</i>	-	-	-	-	X	-
<i>Arethusa bulbosa</i>	-	-	X	X	X	X
<i>Calopogon tuberosus</i>	-	X	X	X	X	X
<i>Cypripedium arietinum</i>	-	-	X	-	-	-
<i>Liparis loeselii</i>	X	-	-	-	-	-
<i>Platanthera clavellata</i>	-	-	-	-	X	-
<i>Platanthera dilatata</i>	-	X	X	-	X	X
<i>Platanthera huronensis</i>	-	-	X	-	X	X
<i>Platanthera leucophaea</i>	X	X	-	-	-	-
<i>Pogonia ophioglossoides</i>	-	X	X	X	X	X
<i>Spiranthes romanzoffiana</i>	X	X	X	X	X	-
<i>Salix candida</i>	X	X	X	X	X	-
<i>Salix pedicellaris</i>	X	X	-	-	-	-
<i>Salix serissima</i>	-	-	X	X	-	-
<i>Betula pumila</i> var. <i>glandulifera</i>	X	X	-	-	-	-
<i>Sarracenia purpurea</i>	X	X	X	X	X	X
<i>Potentilla fruticosa</i>	-	-	-	X	-	-
<i>Potentilla palustris</i>	X	-	-	-	X	-
<i>Rosa palustris</i>	-	-	-	X	-	-
<i>Viola nephrophylla</i>	-	X	-	-	-	-
<i>Epilobium leptophyllum</i>	X	X	X	X	X	-

	RICH	PHRA	L.S.	M.P.	POLT	W.L.
Vascular Plants#						
<i>Epilobium strictum</i>	-	-	X	-	X	-
<i>Andromeda glaucophylla</i>	-	X	X	X	X	X
<i>Chamaedaphne calyculata</i>	-	-	X	-	X	X
<i>Kalmia angustifolia</i>	-	X	X	-	X	-
<i>Ledum groenlandicum</i>	-	X	X	X	X	X
<i>Vaccinium macrocarpon</i>	-	-	X	-	-	X
<i>Vaccinium oxycoccus</i>	-	X	X	X	X	X
<i>Menyanthes trifoliata</i>	X	X	X	X	X	X
<i>Utricularia cornuta</i>	-	-	X	-	-	X
<i>Utricularia intermedia</i>	X	X	X	-	-	X
<i>Utricularia minor</i>	X	-	X	-	X	-
<i>Galium labradoricum</i>	X	X	X	X	X	X
<i>Lonicera oblongifolia</i>	X	X	X	X	-	-
<i>Campanula aparinoides</i>	X	X	X	X	-	-
<i>Lobelia kalmii</i>	X	X	X	-	-	X
<i>Aster borealis</i>	X	X	X	X	X	X
<i>Aster umbellatus</i>	-	X	X	X	-	X
<i>Solidago uliginosa</i>	X	X	X	X	X	X

#designated rare, sparse and uncommon in Gillett and White (1978)
@Adolf Vogg (personal communication 1994)
& Brunton (1990*)
*Paul Catling (personal communication 1991)

Mosses**						
	RICH	PHRA	L.S.	M.P.	POLT	W.L.
<i>Aulacomnium palustre</i>	X	X	X	X	X	-
<i>Calliergon giganteum</i>	X	X	-	-	X	-
<i>Calliergon trifarium</i>	-	-	-	-	-	X
<i>Calliergonella cuspidata</i>	X	X	X	X	X	-
<i>Campylium chrysophyllum</i>	-	X	X	-	-	-
<i>Campylium stellatum</i>	X	X	X	X	X	X
<i>Cinclidium stygium</i>	-	X	-	-	-	X
<i>Drepanocladus vernicosus</i>	X	X	X	X	X	X
<i>Fissidens adianthoides</i>	X	-	X	-	-	-
<i>Meesia triquetra</i>	-	-	X	-	X	X
<i>Paludella squarrosa</i>	-	-	-	-	-	X
<i>Plagiomnium ciliare</i>	-	-	-	-	-	X
<i>Rhizomnium pseudopunctatum</i>	-	-	X	-	-	-
<i>Scorpidium scorpioides</i>	-	X	X	-	-	X
<i>Sphagnum riparium</i>	-	-	-	-	-	X
<i>Sphagnum russowii</i>	-	-	-	-	-	X
<i>Sphagnum squarrosum</i>	-	-	-	X	-	-
<i>Sphagnum teres</i>	-	-	-	-	X	-
<i>Sphagnum warnstorffii</i>	-	-	X	X	X	X
<i>Thuidium delicatulum</i>	X	-	X	-	-	-
<i>Thuidium recognitum</i>	-	X	X	-	-	-
<i>Tomenthypnum falcifolium</i>	-	-	-	-	-	X
<i>Tomenthypnum nitens</i>	-	-	X	-	X	X

**collections by Joyce Reddoch, except most at Manion Corners Long Swamp Fen by Anne Hanes and *Cinclidium stygium* at Phragmites Fen by Gilda Trucco; all mosses identified by Robert R. Ireland.

About the Authors

Joyce and Allan Reddoch's interests in studying native orchids arose from a number of different directions. They have always been interested in nature and in hiking and they are always curious about what they encounter along the way. Their hobby of photography led them to taking pictures of wildflowers and, after joining the Native Orchid Location Survey, more especially of orchids. Their scientific backgrounds prompted them to think in terms of quantitative and statistical techniques when studying various aspects of orchid ecology and taxonomy. Their work has resulted in numerous descriptive articles in *Trail & Landscape* (The Ottawa Field-Naturalists' Club's local natural history journal) and other publications, as well as a taxonomic paper on *Platanthera orbiculata* and *P. macrophylla* in *Lindleyana*. They have given many illustrated talks and lectures to audiences in the Ottawa valley and beyond. With other members of the Club's Conservation Committee, they explored and documented natural areas in the Ottawa District and developed recommendations for the Ottawa-Carleton Regional Official Plan and other land-use planning exercises in Ontario and Quebec. These activities led them to a more complete understanding of the orchids and their habitats in the District as well as the threats to them.

Joyce Marilyn Dunston was born in Mimico (Toronto), Ontario on 27 December 1938, a first generation Canadian of English parents Margery Florence Green and George Vincent Dunston. Joyce grew up in Oakville, Ontario, and earned degrees in chemistry from the University of Toronto (B. Sc. 1961, M. A. 1962, Ph. D. 1966). She did postdoctoral work in organic chemistry and photochemistry at Cornell University and, after moving to Ottawa in the fall of 1966, at Carleton University and the National Research Council. Briefly she was an Assistant Professor in the Chemistry Department at Carleton University.

Since joining The Ottawa Field-Naturalists' Club in 1966, Joyce has been a member of the Council

and of most of its committees. From 1971 to 1979 she was an Associate Editor of *Trail & Landscape* and from 1980 to 1989 she was the Editor. For her contributions to the Club, she received the Member of the Year Award for 1981 and the Service Award of 1989.

In the 1970s, Joyce was the chairman of the Gloucester Environmental Advisory Committee established by the Gloucester Council to advise on environmental matters, a member of the South Nation Conservation Authority representing the Regional Municipality of Ottawa-Carleton and a member of the Club's Conservation Committee, among other conservation activities. The Ottawa Fish and Game Conservation Association awarded Joyce the Murray Boegel Waterfowl Conservation Trophy in 1978 for her work toward protecting wetlands and other significant natural areas in the Region.

Allan Harvey Reddoch was born in Montreal, Quebec on 19 January 1931 to Scottish parents Mary Love Harvey and Allan Reddoch. He attended school in Montreal and in Ottawa where the family arrived early in the Second World War. He then studied chemistry at Queen's University (B. Sc. 1953, M. Sc. 1955) and chemical physics at the University of California at Berkeley (Ph. D. 1960). Returning to Ottawa as a Postdoctoral Fellow at the National Research Council, he subsequently became a Research Officer there until his retirement in 1991. His work involved the application of electron spin resonance spectroscopy to a variety of studies in physical chemistry and solid state physics.

Allan joined The Ottawa Field-Naturalist's Club in 1967 and in the early 1970s became a member of the Club's Council and its Corresponding Secretary. During that time, he was also Chairman of its Conservation Committee when it was involved in the evaluation of candidate natural areas for the Ottawa-Carleton Regional Official Plan and of natural areas in the lands of the National Capital Commission in Ontario and Quebec.

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Advice to Contributors

Content

The Canadian Field-Naturalist is a medium for the publication of scientific papers by amateur and professional naturalists or field-biologists reporting observations and results of investigations in any field of natural history provided that they are original, significant, and relevant to Canada. All readers and other potential contributors are invited to submit for consideration their manuscripts meeting these criteria. The journal also publishes natural history news and comment items if judged by the Editor to be of interest to readers and subscribers, and book reviews. Please correspond with the Book Review Editor concerning suitability of manuscripts for this section. For further information consult: A Publication Policy for the Ottawa Field-Naturalists' Club, 1983. *The Canadian Field-Naturalist* 97(2): 231-234. Potential contributors who are neither members of *The Ottawa Field-Naturalists' Club* nor subscribers to *The Canadian Field-Naturalist* are encouraged to support the journal by becoming either members or subscribers.

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FRANCIS R. COOK, Editor
RR 3 North Augusta, Ontario K0G 1R0

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**The Orchids in the Ottawa District: Floristics, Phytogeography,
Population Studies and Historical Review**

JOYCE M. REDDOCH and ALLAN H. REDDOCH

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The Orchids of the Ottawa District

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Back Numbers and Index

Most back numbers of this journal and its predecessors, *Transactions of The Ottawa Field-Naturalists' Club*, 1879–1886, and *The Ottawa Naturalist*, 1887–1919, and *Transactions of The Ottawa Field-Naturalists' Club and The Ottawa Naturalist* – Index compiled by John M. Gillett, may be purchased from the Business Manager.

Cover: Breaching Sperm Whale, *Physeter macrocephalus*, photographed in 1987 off the Galapagos Islands, Ecuador, by Susan Waters. Courtesy of Hal Whitehead, Department of Biology, Dalhousie University, Halifax, Nova Scotia B3H 4J1. See status report by Reeves and Whitehead, pages 293–307.

The Decline and Current Status of the Dune Race of Dwarf Cherry, *Prunus pumila*, var. *pumila*, on the Canadian Shores of the Lower Great Lakes

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Catling, Paul M., and Brendon M. H. Larson. 1997. The decline and current status of the dune race of Dwarf Cherry, *Prunus pumila* var. *pumila*, on the Canadian shores of the lower Great Lakes. *Canadian Field-Naturalist* 111(2): 187-193.

Based on a survey of the floristic literature, herbarium collections, and recent field study, the dune race of Dwarf Cherry, *Prunus pumila* var. *pumila*, has declined at most of 13 regions of occurrence on the Canadian shores of the lower Great Lakes and is considered threatened. The disappearances or declines at Lake Ontario sites, and at Long Point National Wildlife Area on Lake Erie, and at Pinery Provincial Park on Lake Huron, all followed very high populations of White-tailed Deer (*Odocoileus virginianus*), and current absence or rarity of the shrub at some other locations can also be associated with high deer populations in recent times. Deer have had major impacts on herbs and shrubs in some of the shoreline parks, and were observed to selectively browse Dwarf Cherry. Other factors have probably also played a role in the decline of Dwarf Cherry at some sites, including erosion due to high water levels and shoreline modifications associated with human use. Accurate monitoring of significant natural resources and more effective management of deer populations appears necessary to maintain biodiversity, not only for posterity and science, but also for potential utilization of genetic resources by people.

Key Words: *Prunus pumila* var. *pumila*, Dwarf Cherry, dune race, *Odocoileus virginianus*, White-tailed Deer, conservation, biodiversity, germplasm, Lake Erie, Lake Ontario, Lake Huron, Ontario.

The dune race of Dwarf Cherry (*Prunus pumila* L. var. *pumila*), and other races within the Dwarf Cherry complex, were selected and cultivated for fruit production in the late 1800s (Bailey 1892; Wight 1915). Although little exploited since that time, they are currently important with respect to the development of new Canadian crops and as breeding stock and sources of resistance genes for improvement of existing cherry crops (Lezzoni et al. 1991). Recently, Small (1995) has noted the importance of native fruits as diversification crops in Canada and Davidson (1995) has stressed the need for a concerted effort to determine which taxa are in need of protection. Regardless of previously disputed taxonomic rank (see below), the patterns of geographic variation represented by the four currently recognized varieties of Dwarf Cherry would provide a useful basis for germplasm protection and selection. In many cases the status of native germplasm is unclear, and this applies particularly to native berry plants. However, some species or races are definitely rare or threatened in Canada. In 1993 the most restricted race of Dwarf Cherry, *P. pumila* var. *pumila*, could not be found at one of the best known and accessible stations in Presqu'île Park, eastern Lake

Ontario. This race of Dwarf Cherry was recently highlighted as one of a number of priorities for the protection of Canadian native germplasm of economically important plants (Catling and Porebski 1996). Its apparent decline not only required explanation, but also raised the question of its history and current status elsewhere. In order to contribute to the protection of the dune race of Dwarf Cherry we present information relating to decline and current status on the Canadian shores of Lake Erie, Lake Ontario and southern Lake Huron.

Taxonomic status of Dwarf Cherry

Fernald (1923) established *Prunus susquehanae* Willd. as the correct name for the plant of acid sandy or rocky barrens known as *P. cuneata* Raf., and distinguished the prostrate *P. depressa* Pursh of river gravels from the erect *P. pumila* L. of Great Lakes sand dunes. In his 8th edition of Gray's manual (Fernald 1950) he maintained the three eastern species and included in the group the western *P. besseyi* Bailey, which was reported from Manitoba and Kansas west to Wyoming and Colorado. More recent workers have tended to recognize only one species in the Dwarf Cherry group in eastern North

America, referring all the eastern plants in the group to *P. pumila* (e.g. Boivin 1966; Soper and Heimburger 1982; Voss 1985). Groh and Senn (1940) were also "unable to follow Fernald" and noted that the "entities show a complex series of intergradations", but they did report patterns of occurrence of the taxa in Ontario similar to those outlined by Fernald (1923). Recently, Gleason and Cronquist (1991) recognized the four species as varieties of *Prunus pumila*, the var. *pumila* being the erect, narrow-leaved shrub of dunes along the shores of the Great Lakes. Subsequent reference here to "Dwarf Cherry" refers to the erect, narrow-leaved plant of the Great Lakes dunes.

Methods

Field surveys were conducted at Point Pelee National Park and Rondeau Provincial Park on Lake Erie, and Presqu'ile Provincial Park, Outlet Beach Provincial Park, and Sandbanks Provincial Park on Lake Ontario. Appropriate habitats were systematically searched in 10 m wide paths and the numbers of shrubs seen as well as any evidence of browsing was recorded. Specimens at CAN, DAO, HAM, LKHD, OAC, QK, TRT, TRTE, UWO, and WAT (acronyms from Holmgren et al. 1990) were examined to determine when *P. pumila* var. *pumila* was present and what its status was in the past. Specimens were identified using Fernald's (1950) key, but admitting to var. *pumila* plants with pits 5-8 mm wide instead of 6-8 mm wide. The concept of *P. pumila* var. *pumila* applied here thus involves a narrow-leaved, erect plant with a broad range of pit widths. Locations of collections were mapped and regions of occurrence, i.e.; areas where plants were found from 1 to 200 acres in extent, up to 7 km in length, were indicated. Field botanists and park officials were contacted for information on current status, and available reports concerning vegetation management and monitoring were examined. Relevant botanical literature and crown survey records were also searched for information on the occurrence and status of *P. pumila* var. *pumila* on the Canadian shores of the lower Great Lakes.

Results

Distribution pattern

Specimens exist to substantiate reports from all of the sites listed in Table 1 and shown in Figure 1. Specimens examined were referable to *Prunus pumila* var. *pumila*, the only exceptions being some collections from the Inverhuron shore on Lake Huron, and Point Abino on Lake Erie (Figure 1, Table 1), some of which were referable to var. *depressa* (Pursh) Bean. The only specimens collected near the shore referable to *P. pumila* var. *cuneata* (Raf.) L. H. Bailey (= *P. susquehanae*) were those from sandy oak woodland and prairie-like scrub one to five km distant from the

Lake Erie shore north of Long Point as well as that reported from Lambton, 2 km north of Lake Ontario in the Humber valley of Toronto (Scott 1913), where a similar habitat once existed. Since 1882 Dwarf Cherry has been found at 13 shoreline regions in the eastern lower Great Lakes (Figure 1, Table 1).

Lake Ontario

In 1901 Mrs. Burnham Greeley reported a "species of bilberry which was greatly prized by the early settlers" in western Prince Edward County (Carlisle et al. 1973). Since there are no ericaceous plants in the area, there seems to be little doubt that this was a reference to *Prunus pumila*, which is often referred to locally (and incorrectly) as bilberry or huckleberry.

Dwarf Cherry was reported from Sandbanks (Figure 1 - region 1) by Klugh in 1911. It was common there until the early 1970s (personal observation, specimen labels at DAO - Table 1; Carlisle et al. 1973*; Neugebauer 1974*). In 1994 there were still more than 30 patches in the more remote central portions of the bar, but it had become very scarce at either end, where once abundant. The remaining population, however, appears to be the largest along the Canadian shores of Lakes Erie and Ontario. In the early 1970s, there were still at least seven large clumps on the foredune at Outlet Beach (personal observation), but none could be found in 1993.

Carlisle et al. (1973*) indicated that Dwarf Cherry was one of the dominant species along the front and top of Huycks Bay Bar (Table 1, Figure 1 - region 2). It was frequent at North Beach in 1990 (S. Blaney, personal communication). No additional information is available for either of these sites.

At Presqu'ile Provincial Park (Figure 1 - region 3), Dwarf Cherry was frequent on the foredunes in the late 1960s and early 1970s, when there were at least 15 large patches at the south end of the beach opposite Bluff Island (personal observation). It could not be found in 1993 (personal observation), but a single stem was located in 1996 (S. Blaney, personal communication).

Lake Erie

Zenkert (1934) reported Dwarf Cherry as rare but locally abundant at intervals along the shore from Point Abino to Port Colborne (Figure 1 - region 1). It was collected on Point Abino in 1941, 1948 and 1975, and seen by Yaki and MacDonald in 1988 (MacDonald 1990*). Current status in this area is unclear.

In 1793* William Chewett, then senior surveyor for Upper Canada, noted "innumerable quantities of Dwarf Cherry" eight miles from the eastern extremity

*Document, see Documents Cited between Acknowledgments and Literature Cited.

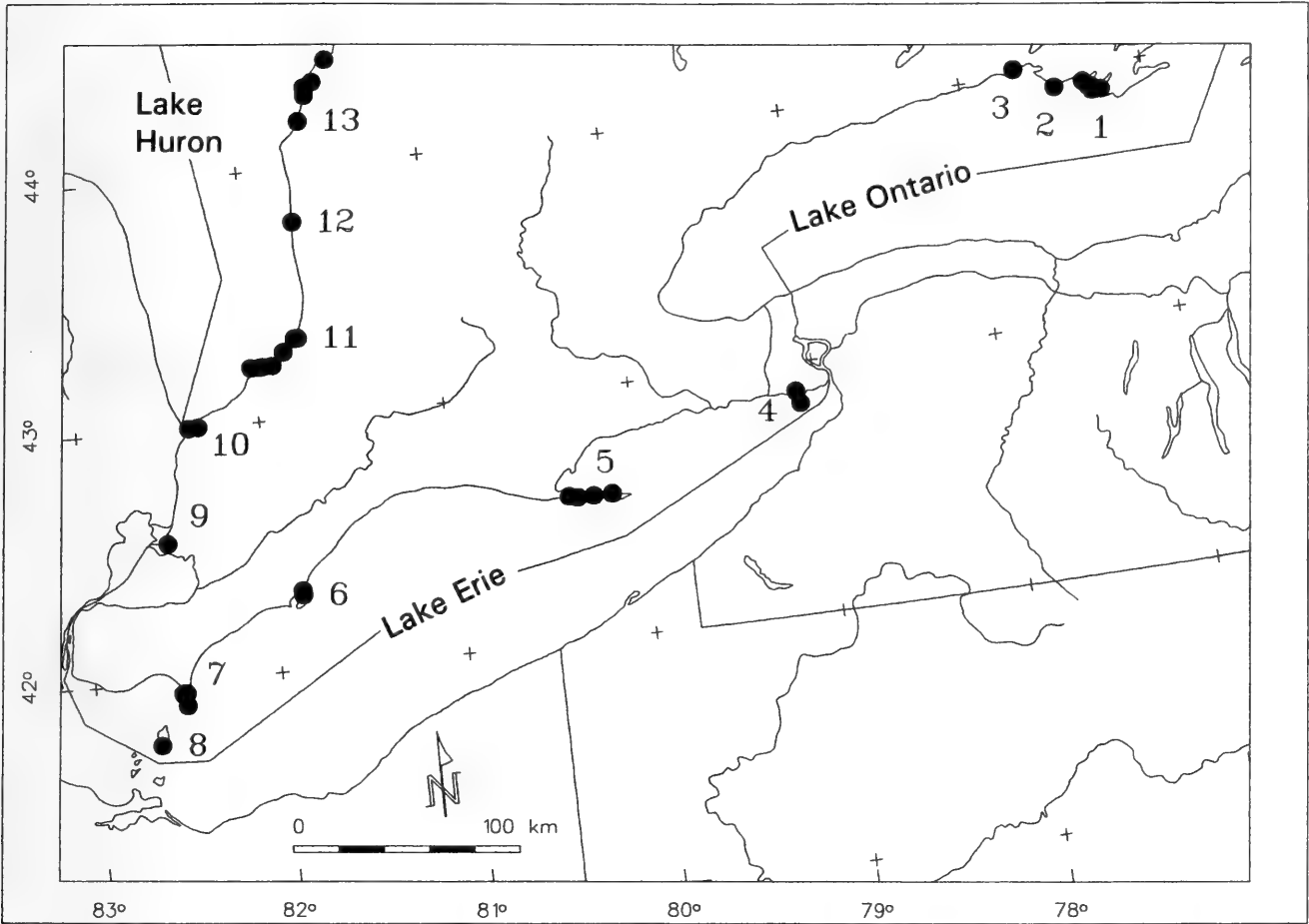


FIGURE 1. Distribution of locations where *Prunus pumila* var. *pumila* has been found on the Canadian shores of the lower Great Lakes (dots) and corresponding regions (numbers). For the basis of the map and key to numbers, see Table 1.

of Long Point (Figure 1 – region 5). James Black’s 1854* survey included a “shrub community” extending from the tip of the point 12 km to the west [see also Heffernan (1978*) and Heffernan and Nelson (1979)]. Dwarf Cherry was one of the species frequently noted in this zone on Black’s transects. Dwarf Cherry was probably not listed in subsequent early surveys of the flora of Norfolk County because it had already become rare. Dwarf Cherry was present, but very rare on the outer portions of Long Point and particularly in the Gravelly Bay area in the late 1960s (personal observation). Heffernan and Nelson (1979) noted that no Dwarf Cherry occurred in the areas where it had been reported by Chewett (1793*) or Black (1854*), and that there were only a few, very small clumps in the Provincial Park at the base of Long Point. Dwarf Cherry was not seen on the outer portions of the point in the 1980s by Reznicek and Catling (1989), who also reported it only from the park at the base of the point.

There is a specimen of Dwarf Cherry from Rondeau Park (Figure 1 – region 6) collected in 1905 (Table 1), but there are no other records from this location, nor was any reference to it at this location found in any of the early surveyor’s notes. It could not be located there in 1994 during a survey of

the entire east beach, although there is extensive sandy shore habitat.

Dodge (1914) noted that Dwarf Cherry was “frequent at Point Pelee (Figure 1 – region 7) in sandy open ground and on upper beach.” Some later references with almost identical wording (e.g., Mosquin 1988*) are evidently based on Dodge’s report. Specimens were collected here between 1882 and the early 1960s (Table 1). W. Botham, who visited Point Pelee frequently between 1950 and 1980 lists no flowering dates, yet he made field notes extensively. Thus he likely either did not observe it or it was very infrequently observed. The only reference he makes to it is a specimen collected by Frith in 1961 in the collection at the park (Botham 1981). The park herbarium contains specimens collected by Frith on the west beach in 1961 and on the east beach in 1962. A specimen collected by Neal in 1948 was from near the tip thus demonstrating that the plants were widespread in the park. Maycock et al. (1978*) found it “restricted and rare” along the west beach in the late 1970s (see also Battin 1975*). Failure to locate Dwarf Cherry in the park in 1994 following a search of both the eastern and western beaches, provides further evidence of a decline at Pelee since Dodge’s time (1914).

TABLE 1. Locations of *Prunus pumila* var. *pumila* on the Canadian shores of Lakes Erie and Ontario. For locations in literature for which no justifying specimens were found, at least one literature report or personal communication is included. Herbarium acronyms are from Holmgren et al. (1990).

Location	Latitude/Longitude	year of collection/collector/herbarium or reference
Lake Ontario		
1. Sandbanks and Outlet	44 56 30 77 19 30 43 54 00 77 16 00	1993 <i>Catling</i> (DAO) 1947 <i>Gillett</i> (DAO), 1948 <i>Soper</i> (TRT, DAO, OAC), 1952 <i>Calder</i> (DAO), 1960 <i>Hainault</i> (QK), 1964 <i>Lubke</i> (UWO), 1965 <i>Garwood</i> (QK), 1967 <i>Garwood</i> et al. (QK), 1967 <i>Baum</i> (DAO), 1969 <i>Catling</i> (LKHD, QK, TRT), 1969 <i>Saifi</i> (CAN, LKHD, TRT), 1977 <i>Conley</i> (OAC), 1979 <i>Crowder</i> (QK)
	43 54 00 77 17 00	1981 <i>Ball</i> (TRTE)
	43 55 20 77 18 00	1993 <i>Catling</i> (DAO)
	43 55 00 77 17 00	1973 <i>Gad et al.</i> (LKHD, TRT), 1980 <i>Bezdek</i> (TRTE)
Outlet Beach	44 53 30 77 13 30	1973 <i>Carlisle</i> et al.
2. Huyck's Bay and North Beach	44 56 00 77 29 45	1973 <i>Carlisle</i> et al.
North Beach	43 57 30 79 31 30	1990 <i>Blaney</i> , personal communication
3. Presqu'ile Park	44 00 00 77 44 00	1969 <i>Catling</i> (TRT)
Lake Erie		
4. Point Abino & Port Colbourne	42 50 00 79 05 00	1941 <i>Soper</i> (DAO, OAC, TRT), 1951 <i>Landon</i> (OAC), 1975 <i>Catling & McKay</i> (DAO, TRT)
	42 53 00 79 06 00	1975 <i>Catling & McKay</i> (DAO, TRT)
5. Long Point, base	42 34 00 80 09 00	1951 <i>Falls & Klawe</i> (TRT, WAT), 1980 <i>Pringle</i> (HAM), 1980 <i>Reznicek & Catling</i> (DAO, MICH)
Long Point, middle	42 33 00 80 06 00	<i>Chewett</i> (1793)
Long Point, tip	42 33 00 80 03 00	<i>Black</i> (1954)
6. Rondeau Park	42 19 00 81 51 00	1905 <i>Fall</i> (TRT)
7. Point Pelee		
South Point	41 45 00 82 40 00	1892 <i>Macoun</i> (CAN)
near tip	41 57 00 82 31 00	(CAN)
east & west beach	41 54 00 82 31 00	1961-62 <i>Frith</i> (Pelee Park herbarium)
		1882 <i>Burgess</i> (DAO, WAT), 1948 <i>Neal</i> (DAO)
8. Fish Point, Pelee Island	41 45 00 82 40 00	1892 <i>Macoun</i> (CAN)
Southern Lake Huron		
9. Walpole Island	42 30 00 82 33 00	1957 <i>Gillett & Senn</i> (DAO)
10. Sarnia, Caratara Park	43 00 20 82 24 20	1962 <i>Stewart</i> (DAO, UWO)
Point Edward	43 00 00 82 25 10	(CAN)
11. Grand Bend to Kettle Point		
Grand Bend	43 19 00 81 45 00	1936 <i>Sutton</i> (UWO), 1940 <i>Soper</i> (DAO, TRT), <i>Brown</i> (TRT)
Pinery Park	43 16 00 81 50 00	1940 <i>Gaiser</i> (HAM), 1960 <i>Scoggan</i> (CAN), 1962 <i>Shaw</i> (UWO), 1969 <i>Cody</i> (DAO), 1974 <i>Montgomery</i> (WAT), 1974 <i>Helley</i> (OAC)
Port Franks	43 13 00 81 54 00	1891 <i>Dearness</i> (DAO), 1919 <i>Tripp</i> (OAC), 1934 <i>Wood</i> (DAO), 1941 <i>Fox</i> (UWO), 1941 <i>Colgrove</i> (UWO), 1957 <i>Gaiser</i> (OAC), 1959 <i>Lamarre</i> (QK), 1983 <i>Tiedje</i> (UWO), <i>Soper</i> (TRT), <i>Crabe</i> (TRTE)
Ipperwash	43 13 00 81 58 00	1906 <i>Tripp</i> (OAC), 1940 <i>Soper et al.</i> (DAO, GH, HAM, TRT); 1946 <i>Gaiser</i> (HAM), 1955 <i>Tamsalu</i> (HAM), 1957 <i>Yang</i> (OAC), 1958 <i>Lamarre</i> (DAO), 1982 <i>Aboud et al.</i> (UWO)
	43 13 00 81 57 00	1960 <i>Stewart</i> (DAO, UWO)
Kettle Point	43 13 00 82 01 00	1934 <i>Gaiser</i> (DAO, HAM)
12. Wright Point	43 48 00 81 44 00	1990 <i>Dalpe</i> (DAO)
13. Inverhuron shore	44 17 00 81 35 00	1963 <i>Stewart</i> (DAO)

There are reports of Dwarf Cherry from Fish Point (Figure 1 – region 8), on Pelee Island (e.g.; Jones 1912; Campbell 1976*), but, interestingly, some important regional sources do not list it (e.g., Dodge 1914; Core 1948; Botham 1981). There is, however, a specimen collected in 1892 (*Macoun* 5608, CAN). Dwarf Cherry has not been observed in several comprehensive field surveys over the past seven years. It

may never have been common on the limited sandy habitats on the island.

Lake Huron and Lake St. Clair

There are old collections of Dwarf Cherry from Walpole Island Indian Reserve (Figure 1 – region 9) and it occurred on the north end of Squirrel Island until 1969 (personal observation). Extensive recent botanical surveys of this valuable natural area over the past 10 years have failed to find Dwarf Cherry (G. Allen and R. Brown, personal communication). There is limited habitat at this site and it may never have been common.

There are old collections of Dwarf Cherry from Sarnia (Figure 1 – region 10, Table 1), but it was not listed for Sarnia by Tiedje and Tiedje (1989). Since botanists have been fairly active in the area (M. J. Oldham, personal observation), it seems likely that Dwarf Cherry is no longer present.

Until seven or eight years ago Dwarf Cherry was abundant or frequent on the first dune ridge extending from Grand Bend to Kettle Point (Figure 1 – region 11), a strip of shore 25 km in length (personal observation; Sparling 1965). It is estimated that Dwarf Cherry has been reduced to 10% of its former cover over the past 10 years along this shore (M. A. Maun, personal communication; Maun and Crabe, *in press*). Nevertheless, this and the population at Sandbanks on Lake Ontario are the largest remaining populations on the Canadian shores of the lower Great Lakes.

Dwarf Cherry has been collected at several locations along the Lake Huron shore near Inverhuron (Figure 1 – regions 12 and 13, Table 1), but no additional information is available on its status in this region or at the nearby Farm Point Provincial Park. Some of the collections from this area are recent in contrast to most Lake Erie regions of occurrence.

Possible causes of decline

Evidence for excessive browsing by White-tailed Deer as a major cause

Recent declines at all of the Lake Ontario sites (regions 1, 2, and 3) as well as the Grand Bend – Kettle Point dunes on Lake Huron (region 11) have been coincident with major increase in populations of White-tailed Deer, *Odocoileus virginianus*, over the past 10 years (D. Tyerman, personal communication; Gedge and Maun 1992). In the latter regions deer have increased to a very high population level over the past 10 years, and the present level is four times that at which deer and browsed vegetation can coexist in balance (Gedge and Maun 1992). The deer have had a devastating impact on low woody vegetation (Landplan Collaborative 1992*; Pearl et al. 1995*; Bakowsky 1996*).

The relatively well documented declines on Long Point prior to 1920, were also coincident with the development of very dense deer population. Shrubs were generally scarce on Long Point in the late

1920s, the scarcity at that time being attributed to “overstocked” deer (Snyder 1931a, b). Snyder included photos of forest and dunes lacking shrubs, and in this respect, comparable to photos published 58 years later (Reznicek and Catling 1989). Deer were introduced to Long Point on several occasions after 1870 during a period when they were extirpated on the mainland (Snyder 1931a, b), and they have continued to profoundly influence the vegetation until very recently (McCullough and Robinson 1988*). Reznicek and Catling (1989) suggested that the absence of shrubs like Dwarf Cherry over large parts of Long Point was probably attributable to the large deer population. They similarly reported (1989, page 157) Dwarf Cherry as “rare, a few shrubs on low dunes near the base of the Point in Long Point Provincial Park”, one of the few regions of the point where heavy human traffic leads to relatively fewer deer.

Declines at Pelee and Rondeau may have slightly preceded the deer population explosion in those locations, but may be accounted for through selective browsing by a steadily growing deer population. The current rarity of Dwarf Cherry at these two sites can be associated with extremely dense populations of deer in recent times. The White-tailed Deer population in Rondeau was very high between 1912 and 1942 and most of the shrubs were destroyed by browsing during this period (Bartlett 1958*). In the late 1960s, at about the time that Dwarf Cherry was last observed in the park, the deer population in Pelee was below the maximum sustainable population level (Theberge and Oosenburg 1975*), but by the early 1990s the deer population had increased six times and was far beyond this level (Maun and Crabe 1995).

In addition to coincidence of the decline of Dwarf Cherry with the increase in deer and well-documented impacts of a few other observations also suggest deer as a major cause of Dwarf Cherry decline. Species of *Prunus*, including Dwarf Cherry, are among the plant species most browsed by deer where they are available (Miller et al. 1992; Strole and Anderson 1992). Dwarf Cherry was selectively browsed by deer at Sandbanks Provincial Park (personal observation) and at Pinery Provincial Park (M. A. Maun, personal communication), and at both locations it was preferred over a number of other woody species. Finally, Dwarf Cherry was least impacted at Long Point and the Grand Bend – Kettle Point shore in built up areas where density of deer was lower (personal observation).

Other factors

The first suggestion of a decline on the Outlet Beach bar was that of Carlisle et al. (1973*), who noted that Beach Grass (*Ammophila breviligulata* Fern.) and Dwarf Cherry were not as common at Outlet as at Sandbanks probably due to increased human traffic at the former site. At Presqu'île, in

addition to human traffic, prevention of dune formation due to scraping of the beach to keep it clean and level, probably contributed to the decline of Dwarf Cherry. Nutrient loading of sand due to use by people and Ring-billed Gulls (*Larus delawarensis* Ord) may also have contributed to the decline at this location. The gulls nest nearby and the beach is sometimes used as a resting area by thousands of birds.

On Long Point changes in sand deposition due to high water levels and shoreline modification have reduced dune habitat in some areas, but as noted by Reznicek and Catling (1989), sand is still accumulating in places and the major shoreline changes are recent, whereas Dwarf Cherry declined on Long Point prior to 1920.

In 1986, high water levels (1.5 m higher than normal) rapidly eroded half of the first dune along the Grand Bend – Kettle Point shore and when the water levels dropped, rapid sand accumulation buried many Dwarf Cherry plants (Gedge and Maun 1992). Recovery from such events is often rapid, however, leading to the conclusion that this was not the most important factor in recent decline.

Conclusions

Considering the preceding observations, Dwarf Cherry has declined in most of 13 regions of occurrence on the Canadian shores of the lower Great Lakes, including all major stations. Severely browsed Dwarf Cherry could be easily overlooked, so it may be premature to say that it has been extirpated in some areas, but regardless of whether it has declined or totally gone, it is threatened on the Canadian shores of the lower Great Lakes. Since the dune race is essentially confined to the Great Lakes shores, and is also rare along much of the United States shorelines of the lower Great Lakes (Bonanno 1993; personal observation), this means that it is at least seriously threatened globally. The two regions where it is still fairly common, Sandbanks and Grand Bend, are particularly important for conservation.

There is compelling evidence that browsing by deer has been an important factor in the decline, but other factors have probably also played a role. A number of the sites where Dwarf Cherry has declined are parks that have had management plans for many years, but to adequately protect significant germplasm and rare plants *in situ*, a focussed program of monitoring and management, including management of deer populations, is necessary. Very extensive data on the impact of excessive browsing by deer on the natural ecosystem and on endangered species has been insufficient to produce effective management. Impact on humans through loss of potentially valuable genetic resources should result in a more determined effort. At some locations where the shrubs have only recently been severely browsed, a substantial recovery from root crowns

and aerial stem bases may be possible, but this possibility diminishes as heavy browsing continues.

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A Taxonomic Study of the Grass Genus *Glyceria* (Mannagrass) in British Columbia

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The relationships among the nine species of *Glyceria* occurring in British Columbia were evaluated using principal components analysis of morphological features. The analysis resolved five distinct species and two groups, each consisting of a pair of similar species. Independent analyses of these two groups indicated both consisted of different, albeit close, species. The interpretation that quantitatively similar species are distinct is corroborated by qualitative differences among those same species. A key to the nine species is included.

Key Words: *Glyceria*, mannagrass, principal components analysis, British Columbia.

The grass genus *Glyceria* is composed of about 25 species, mostly of temperate to subarctic regions of the Northern Hemisphere. The species are all tender and readily eaten, but furnish comparatively little forage since they occur in wet areas, usually in limited quantity (Hitchcock et al. 1969).

The status of the genus in the Province of British Columbia is not a matter on which there is agreement (Table 1). An objective of this study was to clarify what species occur in the province, offer insight into potential taxonomic problems that have surfaced as the new Manual of Grasses is being written; in particular the relationship between *G. striata* and *G. elata* (Barkworth, personal communication) and to quantify the relationships among the species occurring in British Columbia as a first step in determining taxonomic problems requiring more detailed study.

As a starting point, we used the species which had been listed for British Columbia by different authorities (Table 1), but not all the species listed were included in further analyses. *Glyceria declinata* and *G. fluitans* were not found in the herbaria used and were thus excluded from this study and the species *G. pauciflora* was earlier transferred to other genera, *Torreyochloa* (Church 1949) or *Puccinellia* (Hitchcock et al. 1969).

In order to quantitatively describe the relationships among the species of *Glyceria* we used Principal Components Analysis (PCA) of a correlation matrix to assay for distinct groups and determine the features which best distinguish among those groups should they coincide with species designations. PCA has been used, with some success, to estimate relationships among other grass species by Allred (1984), Barkworth (1970) and Rapson and Maze (1994). Discriminant function analysis or

canonical variates analysis was not used since they assume the existence of groups whereas we wished to test for the existence of such.

The most complete key to the *Glyceria* of British Columbia is in the Vascular Plants of British Columbia edited by Douglas et al. (1994). A final objective of this study was to update the key of Douglas et al. (1994) by including our results on the nine species analyzed here.

Materials and Methods

Material studied:

Collections of *G. borealis* (Nash) Batch., *G. canadensis* (Michx.) Trin., *G. elata* (Nash) M. E. Jones, *G. grandis* S. Wats. ex A. Gray, *G. leptostachya* Buckl., *G. maxima* (Hartm.) Holmb., *G. occidentalis* (Piper) J. C. Nels., *G. pulchella* (Nash) K. M. S. and *G. striata* (Lam.) A. S. Hitch. were obtained from UBC, UAC and ALTA. A list of the specimens used in the analysis can be obtained from the senior author on request.

Characters:

The first data set for PCA comprised 16 characters assessed for each of 195 specimens (OTUs). Two criteria were used in choosing the variables. They reflected the form of the grasses and were readily measurable. These variables are: Measurements taken in the Flag leaf: Length of the sheath (SHEATH), blade (BLADEL), ligule (LIGULE) and the width at the mid point of the blade (BLADEW). Inflorescence: Overall length to the tip of the terminal spikelet (INF); overall length to the tip of the terminating spikelet of the lower most branch (BRANCH) and length from the inflorescence axis to the first node of the lower most branch (NODE). The spikelets measured were chosen from the middle

TABLE 1. List of the species recognized as growing in British Columbia by four authorities. +, species recognized; -, species not recognized or beyond the geographic range of the work; ASH, Hitchcock and Chase (1951); CLH, Hitchcock et al. (1969); RLT, Taylor and MacBryde (1977); GWD, Douglas et al., 1994.

Species	Authorities			
	ASH	CLH	RLT	GWD
<i>G. borealis</i>	+	+	+	+
<i>G. canadensis</i>	-	-	+	-
<i>G. declinata</i>	-	-	+	-
<i>G. elata</i>	+	+	+	+
<i>G. fluitans</i>	-	-	+	-
<i>G. grandis</i>	+	+	+	+
<i>G. leptostachya</i>	+	+	+	+
<i>G. maxima</i>	-	-	-	+
<i>G. occidentalis</i>	+	+	+	+
<i>G. pauciflora</i>	+	-	-	-
<i>G. pulchella</i>	-	-	+	-
<i>G. striata</i>	+	+	+	+
Total number of species recognized	6	7	10	8

of the inflorescence, the measurements taken were: Spikelet width at the middle (SPIKW) and length (SPIKL); and the length of the first and second glumes (GL1 and GL2). In the same spikelet we measured in the lowest floret the length of the: Lemma (LEMMA), palea (PALEA), anther (ANTHER) and scarious portion at apex (SAPEX). The number of anthers per floret were counted (NUANT). The variables are listed in Table 2.

TABLE 2. Characters and character states used in principal components analysis.

Variable	Acronym
Flag leaf	
Sheath length	SHEATH
Blade length	BLADEL
Blade width at the midpoint	BLADEW
Ligule length at the middle	LIGULE
Inflorescence	
Overall length from lowest node to tip of terminal spikelet	INF
Length of the lower most branch to tip terminating spikelet	BRANCH
Length of lower most branch from the inflorescence axis to the first node	NODE
Spikelet (chosen from middle of inflorescence)	
Spikelet width at the middle	SPIKW
Spikelet length	SPIKL
First glume length	GL1
Second glume length	GL2
Lowest floret of measured spikelet	
Lemma length	LEMMA
Palea length	PALEA
Number of anthers	NUANT
Anther length	ANTHER
Length of scarious portion of apex measured at midvein	SAPEX

Analyses:
A PCA on the data for all species analyzed. For for those instances where species were not clearly resolved in the initial analyses, a PCA on those species alone was done to see if the resolution could be improved by excluding those species that strongly polarize the data.
The final analyses were not always based on the full set of variables. For all comparisons made, an initial PCA was done on all variables. The variables were then ranked by the square of their eigenvector loadings adjusted by the eigenvalue and summed over all axes. Those sums were then analyzed for natural breaks, variables separated by large values, and all variables with summed values above that natural break were used in the next PCA. This approach was used by Maze et al. (1992) and is designed to

TABLE 3. PCA of all species. Variable acronyms as in Table 2.

	PCA axes	
	1	2
Eigenvalues	6.54	1.23
Percent variation accounted for	65.38	12.26
Eigenvectors		
SHEATH	0.780	0.462
LIGULE	0.754	0.518
INF	0.771	0.338
SPIKL	0.904	0.125
GL1	0.751	-0.482
GL2	0.848	-0.324
LEMMA	0.880	-0.212
PALEA	0.912	-0.184
NUANT	0.763	0.204
ANTHER	0.700	-0.408

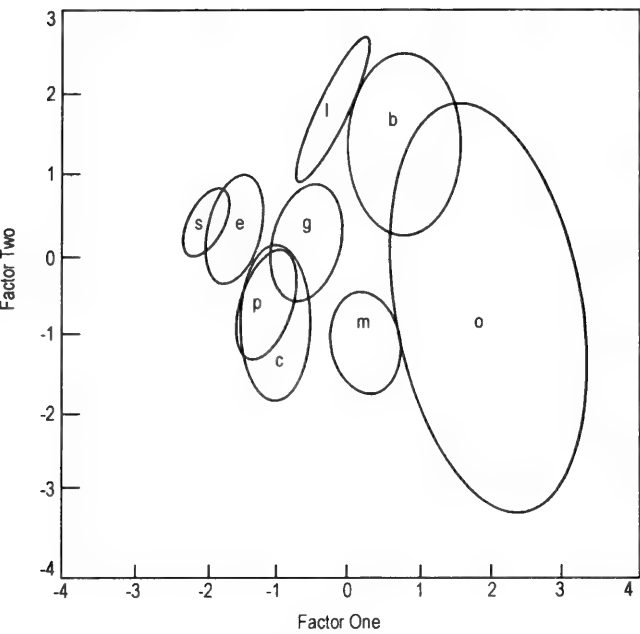


FIGURE 1. 70% confidence ellipses for all nine species. Factor one, first PCA axis; Factor two, second PCA axis; o, *Glyceria occidentalis*; b, *G. borealis*; m, *G. maxima*; l, *G. leptostachya*; g, *G. grandis*; p, *G. pulchella*; c, *G. canadensis*; e, *G. elata*; s, *G. striata*.

eliminate those variables whose vectors do not closely parallel major axes of variation; it is an approach designed to eliminate “noise” in the data. Three PCAs were performed, one for all species, one comparing *G. canadensis* and *G. pulchella* and one comparing *G. elata* and *G. striata*.

The results of the PCA, the PCA axis scores, were used to produce scatter plots, summarized as confidence ellipses, and subjected to analysis of variance (ANOVA) to offer a quantitative summary of the scatter plots. For this we relied on Tukey's multiple range test. In all the comparisons using PCA axis scores we used only the first two axes as these are the ones that account for most the variation in the data.

These and subsequent analytical comparisons were done using SYSTAT Network Version 5.04 Wilkinson (1991).

Results

Analysis of all species:

The first PCA, done with all the variables for all species, resulted in eliminating six variables, BLADEL, BLADEW, BRANCH, NODE, SPIKW and SAPEX. In the PCA on the remaining variables (Table 3), the first axis of the PCA explained 65.38% of the data variation. The characters loading heaviest on this axis pertained to the spikelet and floret characteristics; the four most important were: PALEA, SPIKL, LEMMA and GL2. However all variables have fairly high loading and the same sign indicating the first axis most likely

reflects size differences. The second axis explained 12.26% of the data variation and the most important characteristics were LIGULE, GL1, SHEATH and ANTHER. The presence of both positive and negative signs in the loading on the second axis indicate that differences along that axis represent differences in shape.

Distribution of the study samples along components 1 and 2 is illustrated in the Figure 1. Seven groups can be recognized. Two consist of pairs of closely related species, *G. canadensis* — *G. pulchella* and *G. elata* — *G. striata*, and five species standing apart from each other. Three species, *G. grandis*, *G. leptostachya* and *G. maxima* form a linear series of two related pairs along the first axis, *G. grandis* and *G. leptostachya* and *G. leptostachya* and *G. maxima*. However these three species were not subjected to further analyses. The main axis of variation for *G. leptostachya*, *G. grandis* and *G. maxima* is orthogonal, or nearly so, to the main axes of variation of all the species. Thus when analyzed alone they would be separated along their main axes of variation. The same reasoning was used in not subjecting *G. borealis* and *G. maxima*, which overlap on the first axis, to further analyses.

In the Tukey analysis ($p > 0.05$), *G. canadensis* and *G. pulchella* were not significantly different on components 1 and 2, and in six SHEATH, LIGULE, INF, SPIKL, GL1 and PALEA, characteristics; *G. elata* and *G. striata* were not different on factor 2 and seven characteristics; SHEATH, LIGULE, SPIKL, GL1, GL2, LEMMA, and PALEA. Because of the similarities between first two pairs of species it was necessary to include each pair in further anal-

TABLE 4. PCA of *G. canadensis* and *G. pulchella*. Variable acronyms as in Table 2.

	PCA axes	
	1	2
Eigenvalues	4.06	3.25
Percent variation accounted for	33.83	27.11
Eigenvectors		
SHEATH	0.640	0.469
BLADEL	0.720	0.319
BLADEW	0.595	0.443
LIGULE	0.332	0.683
INF	0.812	0.166
BRANCH	0.548	0.470
RACHIS	0.169	0.653
SPIKW	0.462	-0.695
SPIKL	0.760	-0.440
GL2	0.416	-0.622
LEMMA	0.666	-0.631
PALEA	0.521	-0.363

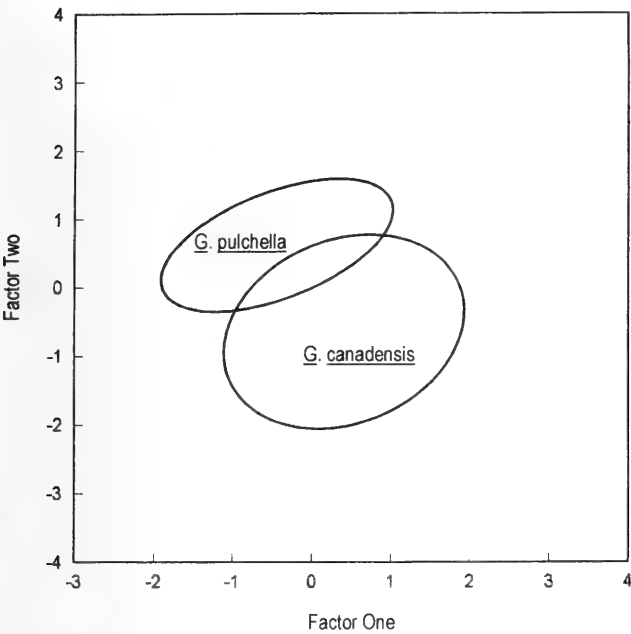


FIGURE 2. 70% confidence ellipses for *Glyceria elata* and *G. striata*. Factor one, first PCA axis; factor two, second PCA axis.

yses, following the same criteria established for all the species.

Analysis of *G. canadensis* and *G. pulchella*:

An initial PCA of only *G. canadensis* and *G. pulchella* using all variables indicated that BRANCH, GL1, NUANT, ANTHERR and SAPEX contributed little to the main axes of variation. Those variables were eliminated and a second PCA was done. The results of that PCA are presented in Table 4. The first axis has all positive loadings with the largest being those for INF, SPIKL,

BLADEL, LEMMA and SHEATH; it accounts for 33.83% of the variation in data; the second axis accounts for 27.11% of the variation in the data. It is a shape axis with two groups of variables being recognized, those for the spikelet variables and those for the vegetative variables and the inflorescence. The variables making the strongest contribution to the second axis are SPIKW, LIGULE, RACHIS, LEMMA and GL2.

The distribution of the study samples along components 1 and 2 is illustrated in the Figure 2. The two species occur in different parts of the ordination and are separated on both axes with the greatest separation being on the second. In the Tukey analysis both species were significantly different on components 1 and 2. The combination of the loadings and position on the ordination indicate *G. pulchella* is smaller than *G. canadensis*.

Analysis of *G. elata* and *G. striata*:

The initial analysis, using all the variables, showed that LIGULE, SPIKW and SAPEX, were not major contributors to the variation and were not considered in the second analysis. The result of the second PCA is shown the Table 5. The factor loadings indicate that component 1 revealed mainly differences in ANTHERR, INF, BRANCH, BLADEW and SHEATH, explaining 38.81% of the data variation, whereas component 2 revealed differences in LEMMA, SPIKL, PALEA, GL2 and BLADEL, explaining 20.01% of the data variation. As in the analysis of *G. canadensis* and *G. pulchella*, the first axis is likely a size axis and the second shape. Also, like *G. canadensis* and *G. pulchella*, the second axis

TABLE 5. PCA of *G. elata* and *G. striata*. Variable acronym as in Table 2.

	PCA axes	
	1	2
Eigenvalues	5.04	2.60
Percent variation accounted for	38.81	20.01
Eigenvectors		
SHEATH	0.634	0.357
BLADEL	0.582	0.480
BLADEW	0.646	0.204
INF	0.796	0.387
BRANCH	0.772	0.395
RACHIS	0.622	0.336
SPIKL	0.463	-0.576
GL1	0.629	-0.423
GL2	0.607	-0.502
LEMMA	0.344	-0.722
PALEA	0.529	-0.529
NUANT	0.502	-0.440
ANTHER	0.801	0.160

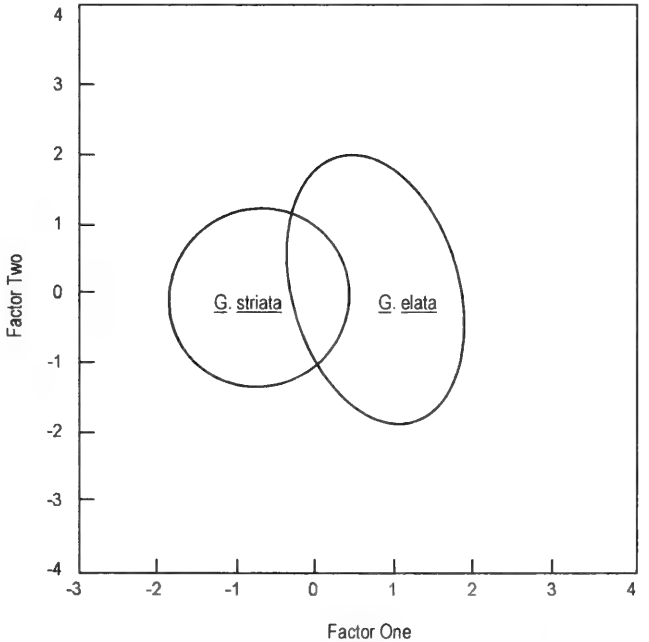


FIGURE 3. 70 % confidence ellipses for *Glyceria canadensis* and *G. pulchella*. Factor one, first PCA axis; factor two, second PCA axis.

is bipolar with the main separation being between spikelet and non-spikelet characters, with the exception of ANTHER. Figure 3 presents the distribution of the *G. striata* and *G. elata* along components 1 and 2.

The two species are separated along the first, but not the second axis. This relationship is reflected in the Tukey analysis wherein the two species are significantly different on the first but not the second axis. The combination of loadings on the first two PCA axes and the loadings on the first PCA axis indicate that *G. striata* is the smaller of the pair.

Discussion

The PCA found a certain number of groupings which coincide most closely with those in Douglas et al. (1994), quantified the distinctiveness of the groups and identified character variation of value for identification of the groups. In those instances where there was apparently some overlap when all species were analyzed, analyses using only the closely related pairs of species, *G. striata* — *G. elata* and *G. canadensis* — *G. pulchella*, indicated the species occupied separate parts of the ordination.

Although the differences among the species are not strong, we feel that we are dealing with distinct species. The reason for this is that differences among the species are often represented in characters that are difficult to quantify without establishing artificial categories; such characters are texture, degree of prominence of lemma nerves, the form of apices of appendages and the shape of structures. The combination of these variables, along with the analyses done, allow the recognition of nine species, and this opinion is presented in a key to the nine species that is presented at the end of this discussion.

The analyses of the pairs of *G. canadensis* — *G. pulchella* and *G. striata* — *G. elata* implies that, once the effect of size has been eliminated, there are different growth responses with the spikelet features showing a different response from those of the vegetative parts of the plant. That such should occur is not surprising. The parts with the different responses are derived from in different physiological states, the vegetative features and inflorescence variables are formed by an induced meristem while the parts of the spikelet are the product of a spikelet meristem. This relationship is, obviously, descriptive. Without differently designed studies, we cannot ascribe any sort of functional or developmental relationship that goes beyond that descriptive. But what is indicated is that a more detailed study directly addressing the development of these species might give some insight into the relationship between the developmental events in parts of different ontogenetic origin.

Key to the species

1. Spikelets 10 - 15 mm long, linear in outline
 2. Lowest lemma 5 - 6 mm long; anthers 1.1 - 1.6 mm long *G. occidentalis*
 2. Lowest lemma 3 - 4 mm long; anthers 0.5 - 1.0 mm long
 3. Blades papillose on the adaxial surface; Lemma scabridulous only on the nerves, the internerves usually glabrous *G. borealis*
 3. Blades scabridulous on the adaxial surface; lemma scabridulous on both nerves and internerves *G. leptostachya*
1. Spikelets 2.5 - 6.5 mm long, ovate to oblong in outline
 4. Nerves of the lemma not prominently raised; Spikelets 3 - 5 mm wide; palea often exposed *G. canadensis*
 4. Nerves of the lemma prominently raised; Spikelets at most about 2.5 mm wide; palea concealed by lemma
 5. First glume 1.3 - 3.5 mm long; palea apices with wide, V-shaped notches
 6. Lemma with broad scarious, margins distinctly erose at top; stamens 2; glumes commonly obtuse. *G. pulchella*
 6. Lemma nearly entire at apex, without or with only inconspicuous scarious margins; stamens 3, rarely 2; glumes acute.
 7. Lowest lemma 2.0 - 2.5 mm long; anthers 0.5 - 0.8 mm long; palea 1.9 - 3 mm long. *G. grandis*
 7. Lowest lemma 2.5 - 3.5 mm long; anthers 1.0 - 2.0 mm long; palea 2.7 - 3.5 mm long, rugose *G. maxima*
 5. First glume 0.6 - 1, rarely to 1.5 mm long; palea apices with narrow slits.
 8. Ligules of the lower leaves usually closed in front, mostly 1 - 3 mm long; blades 2 - 5, occasionally to 6 mm wide; anthers 0.4 - 0.6 mm long; glumes ovate, rounded to obtuse, first glume 0.5 - 0.7, or even to 1 mm long; lemma barely 2 mm long; firm; leaf blades mostly 2 - 4 mm wide; plants 2, but usually 3 - 8 dm tall. *G. striata*
 8. Ligules of the lower leaves usually open in front, mostly 3 - 6 mm long; blades broad, 6 - 10, or even 15 mm broad; anthers 0.7 - 0.8 mm long; glumes lanceolate-ovate, mostly acute, first glume mostly 1 but rarely 0.7 to 1.2 mm long; lemma mostly 2 - 2.2 mm long; leaf blades usually 4 - 10 mm wide; plants mostly 10 - 15 dm tall. *G. elata*

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Coyote, *Canis latrans*, Visitations to Scent Stations in Southeastern Alberta

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Woelfl, Sybille, and Manfred Woelfl. 1997. Coyote, *Canis latrans*, visitations to scent stations in southeastern Alberta. Canadian Field-Naturalist 111(2): 200-203.

During a scent-station survey from July until September 1994 in southeastern Alberta, we found no differences in Coyote, *Canis latrans*, response to the standard attractant FAS (Fatty Acid Scent) and Sardines, *Sardina pilchardus*. However, total September visitation rate was significantly higher than in July or August. This increase was mainly caused by the increasing mobility of pups. Using the scent-station method, we succeeded in documenting Coyote presence in each ecosection. Differences in visitation rates among ecosections existed. There was a negative correlation between the number of visits and the relief of the different ecosections.

Key Words: Coyote, *Canis latrans*, abundance indices, attractant, habitat, scent stations, Alberta.

The scent-station technique was developed to obtain indices of relative abundance of carnivore populations and was originally used for Red Fox (*Vulpes vulpes*) and Gray Fox (*Urocyon cinereoargenteus*) (Wood 1959). It has now been used on Coyotes (*Canis latrans* — Linhart and Knowlton 1975), Bobcats (*Lynx rufus* — Brady 1981; Knowlton and Tzilkowski 1981; Diefenbach et al. 1994), Raccoons (*Procyon lotor* — Smith et al. 1994), Opossums (*Didelphis virginiana* — Sumner and Hill 1980; Conner et al. 1983), Black Bears (*Ursus americanus* — Lindzey et al. 1977), and various small mammals (Barrett 1982; Clark and Campbell 1983). These studies have focused on relationships between population size and scent-station indices (Conner et al. 1983; Diefenbach et al. 1994; Smith et al. 1994), survey design (Roughton and Sweeny 1982; Hatcher and Shaw 1981) and efficiency of odor attractants (Turkowski et al. 1983; Roughton 1982). Debates about type and presentation of attractant, the number of days survey lines should be operated, distances between scent-stations, and the timing of surveys are ongoing.

The purpose of this study was to compare the efficiency of a standard attractant (FAS) with an easily manageable alternative (Sardines, *Sardina pilchardus*) and to evaluate the effect of habitat and month on the visitation rate.

Study Area

The study was conducted in the Canadian Forces Base Suffield in southeastern Alberta (50° 32'N, 110° 32'E). The 420-km² area stretches north of Medicine Hat along the west side of the South Saskatchewan River and is the Dry Mixed Grass Ecoregion comprised of three broad physiographic units: Eastern Alberta Uplands (dominated by glacial

fluvial outwash plains: 24% of the study area), Eastern Alberta Plains (sand hills 36%; moraine deposits 21%) and the South Saskatchewan River Valley (consisting of terraces, ravines and intervening steep slopes; 19%) (Usher and Strong 1994). The Suffield area lies in one of the driest regions in Alberta. The combination of warm summer temperatures (maximum 35-40°C) and low precipitation (summer average 40 mm) produces potential moisture deficits exceeding 100 mm. Winter temperatures average -7.2°C with thin snow cover and relatively few days with continuous snow cover. The Needle Grass-Blue Grama (*Stipa comata-Bouteloua gracilis*) community-type is the most common plant community in the Southern part of the study area and occurs on a variety of landforms. Plant communities with a significant component of sagebrush (*Artemisia cana*) dominate the vegetation in the northern portion, with sagebrush-sand grass (*Calamovilfa longifolia*)/needle grass and sagebrush/needle grass community-types being the most abundant.

Methods

Habitat classification: Usher and Strong (1994) defined 10 different ecosections for the Suffield National Wildlife Area. Basically following their "Ecological Land Classification", we distinguished nine ecosections for our carnivore survey. We considered major landform components based on physiographic and/or geologic patterns (eolian, fluvial, glacial fluvial landforms, and morainal deposits), vegetation (herb/shrub dominant), slope, and drainage. We clustered similar sites and excluded ecosites < 500 ha (Table 1).

Survey Design: Twenty-seven transect lines with 10 scent-stations each were established and con-

TABLE 1. Ecosections (> 500 ha, similar vegetation and slope), based on Usher and Strong (1994), southeastern Alberta.

Ecosection	Description	% Slope	% Shrub	Area (ha)
E 1	Sand Dunes	2-30	99.8	16433
F 1	Ravines	>45	42.1	665
F 2	River Valley	>30	89.1	1452
G 1	Channel Banks	15-30	28.5	846
G 2A – type	Fluvial Terraces (Shrub dominant)	0-5	80.1	729
G 2B – type	Fluvial Terraces (Herb dominant)	0-9	19.9	2239
G 3	Fluvial Outwash	0-15	4.4	11079
M 1	Ground Morain	5-30	–	6987
M 2	Morainal Plain	5-15	51.0	1770

trolled once a month during July, August and September 1994. Depending on accessibility the stations were checked by truck, ATV or on foot. We placed three transects in each of the nine ecotypes, each transect consisting of 10 stations spaced at 0.3 km intervals (Roughton and Sweeny 1982). Distances between the transects varied according to ecosite distribution, but were at least 1500 m apart. At each station, the vegetation was removed, the surface cleared of rocky material, leveled, and smoothed with sifted soil within an area of 1 m². The contrast of foot or paw imprints was improved by using a thin layer of flour. In the center of the circle we placed a wooden stake 0.20 m in height above ground and attached the attractants.

We used two attractants, fatty acid scent (FAS, *see* Roughton and Sweeny 1982) and Sardines (in oil). The liquid FAS was applied to a cottonball and placed in perforated plastic capsules. The sardines were wrapped in short pieces of cotton bandages and, like the FAS capsules, nailed on top of the wooden stake. We alternately activated the stations with FAS or sardines on the first day of the survey and then checked the stations for the next two consecutive days. During the final check of the lines we removed the capsules or sardines from each station. We recorded daily weather conditions, number of inoperable stations (due to unreadable tracks because of weather/livestock disturbance), and species of carnivores and other animals that visited each operable station. While we were checking the lines, tracks were recorded and erased, the ground was smoothed, and a thin layer of flour added. Missing attractants were replaced with fresh capsules or sardines as needed.

Data analyses: We used the Chi-square goodness-of-fit test to determine whether Coyote visitations to the scent-stations differed between type of attractant and month of use. Data were pooled over month to provide a meaningful sample size. Differences among habitat-types were analysed by a least-

squares analysis of variance (ANOVA — SYSTAT, Inc. 1992), and a Tukey Test to determine where differences among the ecosections existed. The visitation rate was calculated according to Linhart and Knowlton (1975) (total Coyote visits/ total operable station nights * 1000).

Results and Discussion

Of 1601 operable station nights, 91 stations were visited by Coyotes and the visitation rate, as calculated by Linhart and Knowlton (1975), was 57. Beside mere sniffing (*n* = 47) Coyotes responded to the scent by carrying the capsule/sardine away (*n* = 33), defecating/urinating (*n* = 7) on the station, scratching (*n* = 3), and biting at the capsule (*n* = 1). Scratching occurred only at stations scented with FAS.

There was no difference in visitation rate between stations scented with FAS versus Sardines (Table 2; $\chi^2 = 2.5$, 1 df, *P* > 0.26). FAS is a commonly used superior attractant that can be used as a standard to which other attractants can be compared (Roughton and Sweeny 1982). Our results suggest that sardines were as effective as FAS.

Sardines are readily available and cost 10% less. However, sardines needed more replacement due to insect and weather related deterioration. FAS needs to be ordered and its acidity demands precautions during handling (Turkowski et al. 1983). Visitation rates to FAS appeared comparable with other studies (e.g., Sumner and Hill 1980; Roughton and Sweeny 1982; Turkowski et al. 1983). However, the basic comparability of scent-station studies is discussed controversially (Diefenbach et al. 1994; Smith et al. 1994).

Number of visits per site was significantly higher in September ($\chi^2 = 9.5$, 2 df, *P* > 0.01) than in July or August (Table 2). Roughton and Sweeney (1982) suggested that timing of a survey was very important and recommended a period when juveniles were dispersing and the population was at its annual peak. Several studies compared the effect of seasons. Stolzenburg and Howard (1989) found monthly peaks in visitation rate of Coyotes during January and September. Martin and Fagre (1988) reported sum-

TABLE 2. Coyote visits to scent-stations with two different attractants during July, August, and September 1994, in southeastern Alberta.

Month	Visits	Attractant	
		FAS	Sardines
July	23	14	9
August	24	11	13
September	44	28	16
TOTAL	91	53	38
Number of operable station nights = 1601			

mer (July–September) and fall (October–December) as the seasons with the highest visitation rates.

Smaller tracks at scent-stations and several sightings of Coyote pups near transect lines indicated that the higher visitation rate during September in our study was caused by increased mobility of pups. The number of transects visited by Coyotes increased from 11 in July, to 13 in August, to 16 in September.

Period of highest response to scent-stations coincides with time of juvenile Coyote dispersal (Stolzenburg and Howard 1989; Martin and Fagre 1988). When the ultimate goal of scent-station surveys is to assess trends in furbearer abundance, we suggest conducting surveys during dispersal periods. Nevertheless the advantage of obtaining higher visitation rates during dispersal and therefore detecting changes in relative abundance more easily (Roughton and Sweeny 1982) was questioned by Diefenbach et al. (1994). They found that increased visitation rates increased the variance; i.e., multiple visits from individuals became more likely, and thus the relationship between population size and scent-station index changed.

There were significant differences in the number of visits among the nine ecotypes (Table 3; $F = 5.456$, 8 df, $P = 0.002$). Differences occurred between ecosections M2 and E1, F1, F2, G1 and M1 ($P_{E1} = 0.006$, $P_{F1} = 0.001$, $P_{F2} = 0.004$, $P_{G1} = 0.040$, $P_{M1} = 0.015$, respectively). However, these results should be treated with caution because ecosection M2 consisted of only one, relatively small unit. Therefore, the three replicates were relatively close together (about 1 km) and not separated by other ecosections. This configuration was very susceptible to multiple visits.

A conspicuous difference throughout the study area was the varying percentage of cover (=sagebrush-sand grass/needle grass plant community-type) per ecosection. Stolzenburg and Howard (1989) explained low visitation rate on one of their two study areas in New Mexico by suggesting that Coyotes in the more open area of the Plains of San

Augustin were more reluctant to investigate the attractants than those on the brushy Jornada del Muerto. In our study (with a non-hunted Coyote population) the ecosections with the highest percentage of shrub vegetation (E1: 99.8%, F1: 42.2%, F2: 89.1%) had the lowest visitation rates. However, there was no correlation between number of visits at the scent-stations and the shrub-percentage per ecosection ($r_s = -0.183$). Cover apparently was not an important factor influencing the visitation rate at the scent-stations.

We found a significant correlation between relief (% slope) of ecosections and number of scent-station visits ($r_s = -0.817$, $P < 0.01$). Landforms with high relief (>15%) had less visits than landforms with low relief (<15%). The steeper and rougher the terrain, the fewer Coyotes visited the scent-stations.

Field observations (tracks, sightings and howling activity) often contradicted the low response to the scent-stations and suggested Coyote presence also in areas with no or very few visits to scent-stations. Along the river shore (F2) or on sandy roads close to the transects (E1) we regularly found fresh Coyote tracks. Along the river shore where Coyote movement was often restricted to a travel corridor <5 m wide between the river and the steep eroded slopes, Coyotes passed the stations very close (<2m), without altering their travel direction or pace, apparently ignoring the scent-stations. Smith et al. (1994) reported that Raccoons although their travel path was in line with an established station, ignored or even avoided the station by veering to one side. One explanation for failure of individual animals to visit stations is that their prior investigation of stations, either on the previous day or elsewhere on the transect, satisfied the animal's curiosity.

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TABLE 3. Coyote visits to scent-stations per transect and ecosection¹ during July–September 1994, southeastern Alberta.

Replicate transect	Ecosections								
	E1	F1	F2	G1	G2A	G2B	G3	M1	M2
# 1	0	0	1	2	7	2	3	2	8
# 2	1	1	2	2	16 ²	6	2	3	10
# 3	3	0	0	4	4	1	5	1	5
Total	4	1	3	8	27	9	10	6	23

¹For definition of ecosections see Table 1.
²Excluded from analysis because transect was situated near a Coyote den.

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Beaver, *Castor canadensis*, Home Range Size and Patterns of Use in the Taiga of Southeastern Manitoba: I. Seasonal Variation

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Wheatley, Michelle. 1997. Beaver, *Castor canadensis*, home range size and patterns of use in the taiga of southeastern Manitoba: I. Seasonal variation. *Canadian Field-Naturalist* 111(2): 204–210.

Seasonal variation in Beaver (*Castor canadensis*) home ranges in the taiga of southeastern Manitoba was monitored by radiotelemetry and visual observations between 1986 and 1992. The results demonstrated that summer home ranges were larger than fall home ranges ($p < 0.001$, $n = 24$). Both summer and fall home ranges were larger than winter home ranges ($p < 0.001$, $n = 19$ and $p < 0.001$, $n = 22$) which were restricted to the vicinity of the lodge. All Beavers had core areas in both summer and fall ($p < 0.05$) but no core areas were present in winter. Core areas were larger in summer than in fall ($p < 0.001$, $n = 24$). However, there was no significant difference in the proportion of the home range made up by the core area in summer (27.2%) and fall (31.7%) ($p > 0.05$, $n = 24$), nor in the proportion of all activity which occurred in the core areas in summer (73.7%) and fall (76.1%) ($p > 0.05$, $n = 24$). Summer and fall home range sizes were positively correlated ($p < 0.001$) as were summer and fall core area sizes ($p < 0.001$).

Key Words: Beaver, *Castor canadensis*, home range, taiga, Manitoba, season.

An animal's home range consists of the area that animal uses during its normal activities of feeding, breeding and raising young (Burt 1943). But animals do not use all areas of their home range equally, resulting in areas of concentrated use or core areas (Springer 1982; Samuel et al. 1985).

Seasonal variation in activity and behaviour has been well documented for Beavers, *Castor canadensis*, in Manitoba (Green 1936), Alberta and the Northwest Territories (Novakowski 1967), Quebec (Potvin and Bovet 1975), Ohio (Brady and Svendsen 1981), California (Busher and Jenkins 1985) and Minnesota (Buech 1995). Similarly the species of tree eaten (Jenkins 1979) and the specific parts of plants eaten (Aleksiuk 1970; Jenkins 1981) have been found to vary seasonally.

Seasonal variation should be most noticeable in regions with the greatest climatic variation among seasons, and especially in regions where Beavers must cope with extended periods of ice cover (Novakowski 1967). In northern regions, Beaver kits are born in late May or early June and much of the summer is devoted to raising these offspring (Banfield 1974). In the north, summer is also a time for rapid growth of kits, yearlings and two-year old Beavers (Aleksiuk and Cowan 1969b). In fall, Beavers build food caches and repair or construct lodges and often dams. Winter is spent almost entirely in the lodge and under the ice, feeding on stored food (Green 1936; Novakowski 1967; Aleksiuk and Cowan 1969a; Potvin and Bovet 1975). Growth is rare in winter, except in kits and sometimes yearlings, and weight loss may often occur (Novakowski 1967; Aleksiuk and Cowan 1969a, 1969b; Aleksiuk

1970). Despite this acknowledged seasonal variation in activities, only Davis (1984) has compared seasonal movement patterns for Beavers, in South Carolina, recording the maximum movement in fall or winter and minimum movement in spring or summer. The taiga accounts for a large proportion of the North American distribution of Beavers. However, most studies of Beavers have been undertaken in more southern regions of the Beavers' distribution, and no quantification of the seasonal variation in Beaver home range size has been made for the taiga regions. The objectives of this study were to quantify the seasonal differences in Beaver home range size, and to compare seasonal patterns of home range use by Beavers in the taiga.

Study Area

This study was based at Taiga Biological Station (TBS), 51°02'40"N, 95°20'40"W, 250 km northeast of Winnipeg, Manitoba. The area was burnt during the 1980 Wallace Lake fire. There are irregular patches of unburned land in the area, some bordering both rivers and lakes. The bogs, and also some ridges where erosion has not been too extensive, support a dense growth of Trembling Aspen (*Populus tremuloides*), Alder (*Alnus crispa*), Black Spruce (*Picea mariana*) and Jack Pine (*Pinus banksiana*).

The climate of the study area is typical for mid-continent boreal forest. Temperatures normally range from -40°C in winter to +35°C in summer (Taiga Biological Station Records). Freeze-up occurs in late October or very early November and breakup in late April or early May. Ice cover is continuous through-

out the period except in areas of fast flowing water. February ice thicknesses range from 50 cm to 100 cm depending upon thickness of the snow cover and air temperatures.

Methods

Between September, 1986 and May, 1992, I live-trapped 60 different Beavers using Hancock traps (Hancock Trap Co., Custer, South Dakota) baited with a piece of Trembling Aspen 30 cm long and a scent consisting of ground up Beaver castor, anise extract and glycerine (Aleksiuk 1968). I measured total length, tail length, ear from notch, hind foot length, and the weight of each animal, and determined the sex by palpating externally for the baculum. To facilitate visual identification of individuals, I attached uniquely numbered and coloured ear tags (Monel Number 3) to both ears (Miller 1964). I installed radio-transmitters using two methods: intraperitoneal implantation (42 transmitters, Austec Electronics, Edmonton, Alberta); and tail collars (3 transmitters, Wildlife Materials Inc., Carbondale, Illinois) (Wheatley 1989, 1994). Beavers were released at the trap site 24 to 48 hours after surgery. All work was approved by the University of Manitoba Animal Care Committee and animals were cared for in accordance with guidelines of the Canadian Council on Animal Care (1980).

I tracked Beavers with an H-shaped antenna and a 24-channel receiver (Wildlife Materials Inc., Carbondale, Illinois). Those animals residing on the river or lake were generally tracked and observed from a canoe, while those living in ponds were observed from a high ridge or similar good vantage point. The telemetry equipment was used to locate the Beaver and then, as much as possible, I continued with visual observations of activities and movements. After dark, I also relied on telemetry to locate animals, but additionally used sounds of chewing or tree felling, or visual observation of water ripples to determine activity. In winter, all movements were monitored by radiotelemetry locations.

I recorded information about the location, time, type of activity and movement during the period of observation. On most nights, I visited each Beaver activity area in turn, but the order of the visits varied so that the same Beaver or group of Beavers was not observed at the same time each night. Observation periods in each activity area varied in length from

TABLE 1. Summary of number of observations per Beaver in each season.

Season	Mean	SE	Minimum	Maximum	N
Summer	724.8	120.8	77	2934	34
Fall	203.7	40.2	45	1134	27
Winter	1008.7	102.1	471	1931	22

TABLE 2. Distribution of Beavers by habitat, season, sex and age class. Habitat designation is based on the location of the primary lodge for each Beaver. Ponds are areas of still water, created and maintained at a relatively constant level by a Beaver dam; lakes are larger areas of non-flowing water, without the presence of a dam and rivers are areas of flowing water, without the presence of any Beaver dams.

Age and sex	Pond			Lake			River			Total		
	Summer	Fall	Winter	Summer	Fall	Winter	Summer	Fall	Winter	Summer	Fall	Winter
Adult male	3	3	3	3	3	3	2	2	1	8	8	7
Adult female	3	2	0	2	2	1	3	2	1	8	6	2
Yearling male	3	1	1	4	3	3	1	0	0	8	4	4
Yearling female	3	1	1	1	1	1	1	1	1	5	3	3
Juvenile male	0	0	0	0	0	0	0	0	0	0	0	0
Juvenile female	2	1	1	1	1	1	2	1	1	5	3	3
Kit male	0	0	0	0	2	2	0	0	0	0	2	2
Kit female	0	0	0	0	1	1	0	0	0	0	1	1
Total	14	8	6	11	13	12	9	6	4	34	27	22

TABLE 3. Home range size (ha) for Beavers for all animals in the study and the subset of the data used for pairwise tests between the seasons are given. Median values followed by different letters (within each group) are significantly different from each other (Wilcoxon Signed Rank Test $p < 0.05$).

Group	Season	Mean (ha)	SE	Median	Minimum	Maximum	N
All	Summer	10.34	1.379	7.875	2.25	42.75	34
	Fall	3.07	0.356	2.750	1.00	8.00	27
	Winter	0.25	0.000	0.250	0.25	0.25	22
Summer - fall	Summer	10.50	1.835	7.625 ^a	2.25	42.75	24
	Fall	3.28	0.380	2.750 ^b	1.00	8.00	24
Summer - winter	Summer	10.29	2.065	7.750 ^c	2.25	42.75	19
	Winter	0.25	0.000	0.250 ^d	0.25	0.25	19
Fall - winter	Fall	2.85	0.320	2.750 ^e	1.00	6.75	22
	Winter	0.25	0.000	0.250 ^f	0.25	0.25	22

0.1 to 13 hours, depending upon weather conditions and the order and number of the activity areas visited. Most observation periods lasted from 0.5 to 4 hours. In open water seasons, most observations were made between 1800 and 2400 h. Earlier research (Wheatley 1989) had shown that most movement about the home range occurred in the first part of the night, while more continuous feeding bouts occurred during the second part of the night (2400 to 0700 h). More visits to the lodge did occur in the first part of the night (Wheatley 1989), so core area estimates may emphasize the lodge area. However, the lodge is used as a rest site for 10 to 12 hours per day, so is clearly going to be an important part of the home range.

I transferred each Beaver's movement data onto maps with grid overlays equivalent to a 50 m by 50 m grid (0.25 ha) on the ground. For this I considered 1 minute as 1 observation because a Beaver can swim approximately 50 m in one minute (personal observation). This does not allow for true independence of observations (Swihart and Slade 1985a; 1985b); however, Beavers move throughout their home range too much to be able to determine home range accurately using less frequent observations.

I defined a year as having three seasons: (1) summer, the period from breakup of ice cover to the beginning of food cache construction; (2) fall, the period from the beginning of food cache construction until freeze-up; and (3) winter, the ice-covered period. I tallied the number of observations in each grid cell and the total number of observations for each Beaver for each season.

Samuel et al. (1985) described a method of determining core areas of home ranges based on the number of observations in each grid cell. Their method, based on the Kolmogorov-Smirnov one-tailed goodness-of-fit procedure, was found to be unreliable and the chi-square goodness-of-fit procedure was recommended in its place (Samuel and Green 1988). To determine the core area of each individual's home range, I compared the observed values in each cell

with the hypothesized uniform distribution for each Beaver using the chi-square goodness-of-fit procedure (Fowler and Cohen 1986). If this test showed that a core area was present, I classed all cells with a greater proportion of observations than uniform as core areas (Samuel et al. 1985). I then transferred to the map the outline of the home range and core areas within the home range. I did this for each Beaver in each season. While other methods of home range and core area analysis are available, my examination of several of these methods showed the grid method to be most suitable for analysis of the Beaver home ranges (Wheatley 1994).

I calculated home range size and core area size by totalling the number of grid cells in each. I calculated the percent of home range that was included in the core area for each Beaver, and refer to this as core percent. I calculated core activity as the percent of all observations that occurred within the core area.

All statistical analyses were made using non-parametric statistics because the data did not meet the normality assumptions of parametric statistics. I used the Wilcoxon Matched Pairs Test to test differences in the variables between each of the seasons, and Spearman Rank Correlation to determine correlations between the same variables for summer and fall, and between variables within each season (Fowler and Cohen 1986). Although data for all Beavers are presented, all statistical comparisons between seasons are made only for those Beavers where paired tests are possible in order to limit the

TABLE 4. Spearman Rank Correlation Coefficients between summer and fall variables.

Variable	r_s (Summer-Fall)	N	P
Home Range	0.665	24	<0.001
Core Area	0.619	24	<0.005
Core Percent	-0.016	24	NS
Core Activity	0.071	24	NS

TABLE 5. Core area size (ha) for Beavers for all animals and the subset of the data used for pairwise statistical analysis. Median values followed by different letters are significantly different from each other (Wilcoxon Signed Rank Test, $p < 0.05$)

Group	Season	Mean (ha)	SE	Median	Minimum	Maximum	N
All	Summer	2.79	0.442	2.125	0.75	14.25	34
	Fall	0.94	0.130	0.750	0.25	2.75	27
Paired data	Summer	2.93	0.612	2.000 ^a	0.75	14.25	24
	Fall	1.03	0.669	0.750 ^b	0.50	2.75	24

influence of other factors such as family status, sex, age class and habitat, which are examined separately (Wheatley 1997a, 1997b).

Results

Home range size was determined for 34 Beavers in summer, 27 in fall and 22 in winter. A summary of the number of observations on which these home range estimates were based is given in Table 1. Twenty-four of these Beavers were matched summer-fall pairs, 22 fall-winter pairs and 19 summer-winter pairs. The breakdown of these Beavers by sex, age and habitat is given in Table 2. Core areas were documented for all Beavers in both summer (chi-square test, $p < 0.01$) and fall ($p < 0.05$). In winter, activity was restricted to one grid square and therefore there were no core areas. Home ranges usually followed shorelines and core areas only occasionally included areas of open water, but these were usually associated with food piles. Usually, several unconnected areas constituted the core area (multiple core areas). Main lodges were usually to one side or one end of the home range, and rarely towards the centre. Beavers used almost all of their home range each night.

All Beavers had different summer and fall home ranges based on differences in location, size, shape and intensity of use. Fall home ranges generally consisted of a portion of the summer home range but some new areas were often included in fall. Likewise, most Beavers used the same lodge year-round, but five beavers (one family and one individual) built new lodges in the fall. Changes in home range use coincided with changes in location of food harvesting sites. In winter Beavers usually remained outside the lodge only for a few minutes at a time,

but Beavers spent extended periods outside the lodge in winter if the water level under the ice dropped, creating air spaces. Even when these conditions occurred, they never appeared to travel much beyond the food pile.

Home ranges were larger in summer than in fall (Table 3), and for the matched summer-fall pairs, this difference was significant (Wilcoxon Signed Rank Test, $T = 1.0$, $p < 0.001$, $n = 24$) and summer and fall home ranges were significantly positively correlated (Table 4). Winter home ranges were significantly smaller than matched summer home ranges ($T = 0$, $p < 0.001$, $n = 19$) and fall home ranges ($T = 0$, $p < 0.001$, $n = 22$) (Table 3). Core areas were also larger in summer than fall (Table 5) and within the matched group the difference was significant ($T = 6.5$, $p < 0.001$, $n = 24$) and also positively correlated (Table 4).

Core percent did not differ between summer and fall (Table 6) ($T = 89$, $p > 0.05$, $n = 24$) and values for the two seasons were not significantly correlated (Table 4). Neither did core activity differ between summer and fall (Table 7) ($T = 123$, $p > 0.05$, $n = 24$) and there was no significant correlation (Table 4).

In summer, there was a significant positive correlation between home range size and core area size (Table 8). There was no significant correlation between any of the other summer variables (Table 8). In fall, home range size and core area were also significantly positively correlated as were core area and core percent (Table 9). There was a significant negative correlation between home range size and core activity in the fall (Table 9). There was no significant correlation between any of the other fall variables (Table 9).

TABLE 6. Percent of home range included in the core area (core percent) for all animals and the subset of data used for paired statistical analysis. Median values in the paired group are not significantly different from each other (Wilcoxon Signed Rank Test, $p > 0.05$).

Group	Season	Mean (%)	SE	Median	Minimum	Maximum	N
All	Summer	27.22	0.963	26.201	16.36	37.50	34
	Fall	31.68	2.622	30.000	16.67	75.00	27
Paired data	Summer	27.62	1.095	26.794	16.36	37.04	24
	Fall	33.41	2.748	30.385	18.18	75.00	24

TABLE 7. Percent of all activity occurring in the core area (core activity) for all Beavers and for the subset of the data used for the pairwise statistical test. Median values in the paired group are not significantly different from each other (Wilcoxon Matched Pairs Test, $p > 0.05$).

Group	Season	Mean (%)	SE	Median	Minimum	Maximum	N
All	Summer	73.68	1.159	75.27	60.89	84.40	34
	Fall	76.14	1.874	77.20	53.50	95.40	27
Paired data	Summer	73.69	1.450	75.365	60.89	84.40	24
	Fall	75.64	2.085	76.630	53.50	95.40	24

Discussion

Seasonal variations in home range size have been described for many animals (including Mountain Sheep (*Ovis* spp.) (Geist 1971), Muskrat (Danell 1978; MacArthur 1978; Proulx and Gilbert 1983), Coyotes (*Canis latrans*) (Springer 1982) and Porcupines (*Erethizon dorsatum*) (Craig and Keller 1986)) and are consistent with seasonal differences in activities and food availability. The limited previous studies of Beaver home range size have focussed primarily on the summer. Busher (1975) reported home ranges 200 m to 800 m long for Beavers in California and Gillespie (1977) found home range sizes of 0.4 to 22 ha for Beavers in southern Ontario. Davis (1984) measured the nightly distance between extreme points in South Carolina as 84 m to 1863 m for the whole year. While in general slightly lower than the summer home range sizes of 2.25 to 42.75 ha in this present study, these estimates are none the less comparable.

Only Davis (1984) has measured seasonal differences in patterns of home range use. His work showed that total daily movement was greatest in fall or winter and least in spring and summer, while the distances between extremes showed maxima in spring or fall and minima in summer. Data in the present study showed that taiga Beaver home ranges also vary seasonally in size, but the results differ sharply from Davis' results in that home ranges were largest in summer, smallest in winter and intermediate in fall. In South Carolina, winter ice cover was not present, and since nights are longer in winter than in summer, Beavers have more time to travel farther afield in search of food or for exploration. Beavers in South Carolina also do not have to build food caches in the fall for winter use, allowing greater freedom of movement in the fall. In the taiga,

Beavers must build a food cache in fall and rely on this cache for up to six months of ice cover. This is an important difference in the obligate seasonal activities between the two regions. Similar to Davis' findings, Busher and Jenkins (1985) found that much more time was spent outside the rest site (lodge) in fall than in summer. However, time outside the rest site does not necessarily imply a larger home range.

Jenkins (1981) reported a seasonal change in feeding site, possibly as a result of a seasonal preference for different species of trees, or because of seasonal variation in site accessibility. Similar seasonal changes in food choice occurred in my study area (Wheatley 1994). But in contrast to other studies (Green 1936; Tevis 1950; Townsend 1953; Brenner 1962; Northcott 1971; Gillespie 1977; Svendsen 1980; Jenkins 1981; Belovsky 1984), the Beavers in my study area did not rely heavily on aquatic vegetation (Wheatley 1994). Fall home ranges usually consisted of a portion of the summer home range, but in some cases contained new area not included in the summer range. Fall food harvesting sites were usually situated within summer home ranges in areas close to the lodge, but were not used as sources of food in the summer. This could reflect a seasonal difference in food preference, a method of reducing energy expenditure in the fall by reducing the distance that food must be transported to the food cache, or a means of extending the time period over which a particular lodge site is usable. MacArthur (1978) proposed a similar explanation for the reduction in size of Muskrat foraging areas as winter advanced.

Semyonoff (1953) (working in the Russian taiga), Lancia (1979), and Lancia et al. (1982) (working in Massachusetts) reported more winter movement than I found in Beavers in the Manitoba taiga. However, Semyonoff's Beavers used sushinetz (air spaces

TABLE 8. Spearman Rank Correlation Coefficients between summer variables, n = 34.

	Home Range	Core Area	Core Percent
Core Area	0.939***	1.00	
Core Percent	-0.252 ^{NS}	0.036 ^{NS}	1.00
Core Activity	0.108 ^{NS}	0.250 ^{NS}	0.228 ^{NS}

*** = $p < 0.001$, NS = not significant.

TABLE 9. Spearman Rank Correlation Coefficients between fall variables, n = 27.

	Home Range	Core Area	Core Percent
Core Area	0.796***	1.00	
Core Percent	-0.108 ^{NS}	0.468**	1.00
Core Activity	-0.482**	-0.218 ^{NS}	0.320 ^{NS}

*** = $p < 0.001$, ** = $p < 0.01$, NS = not significant.

under the ice) extensively and Lancia's Beavers were active fairly frequently above the ice. Smith and Peterson (1991) found behaviour similar to Semyonoff when water levels under the ice dropped and speculated that there was a thermal advantage to staying in the air spaces under the ice. Beavers in the present study did not move extensively using the sushinets, when they occurred. This is most likely due to the hindrance imposed by the irregular shape of shorelines and frequent location of lodges on islands.

Core areas were larger in summer than fall, consistent with the seasonal differences in home range size but core activity and the percent of the home range included in core areas did not differ between summer and fall. No other studies have quantified core area size, but Davis (1984) reported areas of concentrated use when food was clumped, but not when food was regularly distributed. Knowledge about core areas and the pattern of use of home ranges (as reflected by data for core activity and the core percent) are important in understanding how a species uses its environment. No other studies have examined these variables for Beavers, so a comparison to some other species is necessitated. Beavers in the taiga appear to have some inherent pattern of use of their home range such that about 75% of their activity takes place in about 27% of their home range. This value for core activity is similar to Springer's (1982) value of 82.9% Coyotes (*Canis latrans*) and Samuel et al.'s (1985) value of 76% for Black Bears (*Ursus americanus*). For core percent, the percent of the home range included in the core area, Springer's (1982) value of 6.9% for Coyotes is much lower than my value for Beavers, while Samuel et al.'s (1985) value of 34% for Black Bears is much more similar to my value for Beavers. As with the Beavers in this study, both the Black Bears and Coyotes had multiple core areas (Springer 1982; Samuel et al. 1985). For the Beavers, these patterns of home range use may be related to food availability in the area, to habitat types, or to other factors that we cannot detect. The correlation between summer and fall home range size may likewise indicate that the home range size reflects the habitat, or possibly quality of the habitat, in which the lodge is situated.

There are many other factors which also affect home range size. These include the age and the sex of the Beaver and whether they are part of a family group (Wheatley 1997a), the habitat in which the Beavers live (Wheatley 1997b), and the shape and size of the body of water on which they live (Gillespie 1975; Wheatley 1994). Statistical analysis of the interactions between these different factors is difficult to achieve due to the large numbers of animals that would be necessary. But by using the matched pairs statistical procedures, it is possible make the comparison between seasons, without having to include consideration of these other factors.

In this study I have shown that, in the taiga, Beavers have home ranges that are largest in summer, smallest in winter and intermediate in fall. While summer values of home range size are comparable to data from other regions, there are major differences between my findings for seasonal variation in home range size for taiga Beaver and the findings for Beavers in more temperate regions. The correlations between summer and fall home range sizes and core sizes, and the similarity in core percent and core activity between the two seasons indicates that there may be some inherent pattern of home range use possibly related to food harvest sites or food availability. The differences from other studies reflect the differences in seasonal activities necessitated by the extended winter period and preparations for this period. These results must be considered to reflect Beaver behaviour in the mid-continental taiga, and not necessarily other regions of North America.

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Beaver, *Castor canadensis*, Home Range Size and Patterns of Use in the Taiga of Southeastern Manitoba: II. Sex, Age, and Family Status

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The differences in home range size and patterns of use relating to age, sex and family status for 25 Beavers living in family groups, and 9 non-family Beavers in summer and 23 family and 4 non-family Beavers in fall, were examined in southeastern Manitoba. Home ranges were larger for non-family Beavers ($\bar{x} = 17.56 \pm 3.8$ ha, $n = 9$) than for those living in family ($\bar{x} = 7.74 \pm 0.87$ ha, $n = 25$) groups in summer ($T = 233.5$, $p < 0.005$) but not in fall ($T = 78.5$, $p > 0.1$). Core areas were also larger for non-family animals in summer ($T = 211.5$, $p < 0.05$) but not in fall ($T = 63$, $p > 0.1$). The percent of home range area included in the core area and the percent of activity within the core area did not differ significantly between family and non-family Beavers in either season ($p > 0.1$). Within families, adult females had smaller home ranges than other family members in summer ($p < 0.05$) but not in fall ($p > 0.1$). Home ranges did not differ significantly in size among all other family members in both summer and fall ($p > 0.05$). Core area size, percent of home range area included in the core area and percent of activity within the core area did not differ among the sex and age classes within family groups ($p > 0.1$).

Key Words: Beaver, *Castor canadensis*, home range, boreal forest, Manitoba.

Beavers are generally considered to be a monogamous species (Jenkins and Busher 1979) having a prolonged term of parental care. Beaver families spend much of the summer raising kits that were born in late May or early June (Banfield 1974). In northern regions, summer is also the primary time of year for growth and fat deposition (Aleksiuk and Cowan 1969a, 1969b). In fall, Beavers build food caches and repair or construct lodges and dams. Winter is spent almost entirely in the lodge and under the ice, feeding on the stored food (Novakowski 1967). Growth is rare in winter, except in kits and yearlings, and weight loss may occur (Novakowski 1967; Aleksiuk and Cowan 1969a, 1969b). Parental care usually continues through the second year of life, but yearlings also assist in the care of the kits. Subadults generally leave their natal lodge at two years of age, but occasionally leave at their first birthday or stay beyond their second birthday (Jenkins and Busher 1979).

Hodgdon and Larson (1973) and Busher and Jenkins (1985) reported differences in behavioural patterns between adult male and female Beavers, while Buech (1995) cited differences in the time spent on different types of activities by adult males and females, and Townsend (1953) reported differences in movement patterns between adult males and females. In addition, Busher and Jenkins (1985) noted that yearling female behaviour was more like that of adult females, while yearling male behaviour was more like that of kits. Brady and Svendsen (1981) found sex and age class differences in the interactions between animals. Davis (1984) assumed that no such differences in movement or behaviour patterns existed. No

authors appear to have examined variations in home range size among Beavers in different sex and age classes. The objective of this study was to examine patterns of use of home range by Beavers according to sex and age classes both for Beavers living in family groups and for non-family Beavers.

Methods

The study area, methods of capturing, marking and tracking Beavers, and data manipulation are described in Wheatley (1997). I used Buckley and Libby's (1955) classification system to separate the different age classes. "Kits" were animals less than 12 months of age, "yearlings" referred to Beavers in their second year of life and "juveniles", to those in their third year of life. "Adult" referred to any Beaver over 36 months. Beavers were classed as being part of a "family" if they were living in a lodge where there was a breeding pair, and therefore kits. All "non-family" Beavers were either solitary, or if living with another beaver, were not breeding or resident in a lodge with a breeding pair and kits.

Since earlier analysis had shown significant seasonal differences in home range size for Beavers (Wheatley 1997), all analysis of differences between family and non-family Beavers and between sex and age classes of family Beavers was carried out within each season (summer and fall). I calculated home range size and core area size by totalling the number of grid cells in each (Wheatley 1997). I calculated the percent of home range that was included in the core area for each Beaver, and refer to this as core percent. I calculated core activi-

TABLE 1. Summer home range size (ha) for Beavers comparing all family and non-family animals (Mann Whitney U test), different age classes and sexes within family groups (Kruskal-Wallis Analysis of Variance) and males and females in the non-family group (Mann Whitney U test). Median values followed by different letters are significantly different from each other ($p < 0.05$) (within each group — all Beavers, family only and non-family only). All other comparisons within each group are not significantly different ($p > 0.05$).

Family Status	Age Class and Sex	Mean (ha)	SE	Median	Minimum	Maximum	N
Family	All	7.74	0.869	6.750 ^a	2.25	20.50	25
Non-family	All	17.56	3.804	14.000 ^b	4.75	42.75	9
Family	Adult Male	10.89	5.789	7.750 ^c	5.25	20.50	7
	Adult Female	4.39	0.946	4.005 ^d	2.25	9.50	7
	Yearling Male	8.25	2.449	7.250	5.75	11.75	5
	Yearling Female	7.69	1.804	7.000	4.25	12.50	4
	Juvenile Female	7.25	0.750	7.250	6.50	8.00	2
Non-family	Male	13.31	3.282	13.875	4.75	20.75	4
	Female	20.95	6.258	14.500	8.25	42.75	5

ty as the percent of all observations that occurred within the core area.

The data were analysed by sex and age class and family status. I tested for differences between family and non-family Beavers using the Mann-Whitney U Test (Fowler and Cohen 1986). Within known family Beavers I tested for differences due to age and sex using the Kruskal-Wallis One Way Analysis of Variance, with subsequent multiple comparisons if the Kruskal-Wallis Test Statistic indicated a significant difference among the groups (Conover 1980). The group of non-family Beavers did not have sufficient numbers in the different sex and age classes to allow for statistical comparison when separated into these classes, so data are summarised by sex for the non-family group.

Results

I captured and ear tagged 60 different Beavers, and installed 42 radiotransmitters. I was able to

identify home ranges of 25 animals living in family groups, and nine non-family animals in summer and 23 family and four non-family Beavers in fall. Non-family Beavers included five juvenile females, one adult male and three yearling males in summer and three juvenile females and one adult male in fall.

While all Beavers living within the same family group customarily used the same general area for their home range, the different family members did not usually associate together at any particular feeding site or other location. When kits were present in the lodge, one of the family members was usually present in or near the lodge at all times. During the observation periods, I observed all family members taking food into the lodge, apparently for the kits. In fall, kits were active outside the lodge, but remained in the vicinity of the lodge.

Summer home ranges for Beavers living in families were significantly smaller than those of non-

TABLE 2. Fall home range size (ha) for Beavers comparing all family and non-family animals (Mann Whitney U test), different age classes and sexes within family groups (Kruskal-Wallis Analysis of Variance) and males and females in the non-family group (no statistical test, sample size too small). Median values are not significantly different from each other ($p > 0.05$) (within each group — all Beavers and family only).

Family Status	Age Class and Sex	Mean (ha)	SE	Median	Minimum	Maximum	N
Family	All	2.87	0.378	2.500 ^a	1.00	8.00	23
Non-family	All	4.25	0.919	3.875 ^a	2.75	6.50	4
Family	Adult Male	3.96	0.935	2.750 ^c	1.00	8.00	7
	Adult Female	1.90	0.341	2.000 ^c	1.00	2.75	5
	Yearling Male	3.13	0.260	3.125 ^c	2.50	3.75	4
	Yearling Female	2.25	1.010	1.500 ^c	1.00	4.25	3
	Juvenile Female	5.25	0.000	5.250 ^c	5.25	5.25	1
	Kits	1.42	0.083	1.500 ^c	1.25	1.50	3
Non-family	Male	2.75	0.000	2.750	2.75	2.75	1
	Female	4.75	1.090	5.000	2.75	6.50	3

TABLE 3. Summer core area size (ha) for Beavers comparing all family and non-family animals (Mann Whitney U test), different age classes and sexes within family groups (Kruskal-Wallis Analysis of Variance) and males and females in the non-family group (Mann Whitney U test). Median values followed by different letters are significantly different from each other ($p < 0.05$) (within each group — all Beavers, family only and non-family only). All other comparisons within each group are not significantly different ($p > 0.05$).

Family Status	Age Class and Sex	Mean (ha)	SE	Median	Minimum	Maximum	N
Family	All	2.10	0.204	1.750 ^a	0.75	4.50	25
Non-family	All	4.72	1.440	3.000 ^b	1.00	13.25	9
Family	Adult Male	2.82	0.422	2.500	1.75	4.50	7
	Adult Female	1.32	0.335	1.250	0.75	3.25	7
	Yearling Male	2.10	0.232	2.000	1.50	2.75	5
	Yearling Female	2.13	0.924	2.000	1.25	3.25	4
	Juvenile Female	2.25	0.750	2.250	1.50	3.00	2
Non-family	Male	2.75	0.700	3.000	1.00	4.00	4
	Female	6.30	2.402	3.000	2.00	14.25	5

TABLE 4. Fall core area size (ha) for Beavers comparing all family and non-family animals (Mann Whitney U test), different age classes and sexes within family groups (Kruskal-Wallis Analysis of Variance) and males and females in the non-family group (no statistical test, sample size too small). Median values are not significantly different from each other ($p > 0.05$) (within each group — all Beavers and family only).

Family Status	Age Class and Sex	Mean (ha)	SE	Median	Minimum	Maximum	N
Family	All	0.90	0.133	0.750	0.25	2.75	23
Non-family	All	1.19	0.472	0.875	0.50	2.50	4
Family	Adult Male	1.32	0.317	1.250	0.50	2.75	7
	Adult Female	0.55	0.050	0.500	0.50	0.75	5
	Yearling Male	0.88	0.072	0.875	0.75	1.00	4
	Yearling Female	0.83	0.220	0.750	0.50	1.25	3
	Juvenile Female	2.00	0.000	2.000	2.00	2.00	1
	Kits	0.25	0.000	0.250	0.25	0.25	3
Non-family	Male	0.50	0.000	0.500	0.50	0.50	1
	Female	1.42	0.583	1.250	0.50	2.50	3

TABLE 5. Percent of home range area included in the core area (core percent) in summer for Beavers, comparing all family and non-family animals (Mann Whitney U test), different age classes and sexes within family groups (Kruskal-Wallis Analysis of Variance) and males and females in the non-family group (Mann Whitney U test). Median values are not significantly different from each other ($p > 0.05$) (within each group — all Beavers, family only and non-family only).

Family Status	Age Class and Sex	Mean (%)	SE	Median	Minimum	Maximum	N
Family	All	28.22	0.984	27.273	19.51	37.50	25
Non-family	All	24.46	2.255	24.000	16.36	35.51	9
Family	Adult Male	27.78	2.073	28.125	19.51	33.33	7
	Adult Female	29.63	1.340	30.000	25.00	34.21	7
	Yearling Male	26.24	2.845	24.138	20.52	37.04	5
	Yearling Female	27.95	1.116	27.749	26.00	30.30	4
	Juvenile Female	30.29	7.212	30.288	23.08	37.50	2
Non-family	Male	21.02	2.699	19.562	16.36	28.57	4
	Female	27.21	3.111	24.242	18.97	35.51	5

TABLE 6. Percent of home range area included in the core area (core percent) in fall for Beavers, comparing all family and non-family animals (Mann Whitney U test), different age classes and sexes within family groups (Kruskal-Wallis Analysis of Variance) and males and females in the non-family group (no statistical test, sample size too small). Median values are not significantly different from each other ($p > 0.05$) (within each group — all Beavers and family only).

Family Status	Age Class and Sex	Mean (%)	SE	Median	Minimum	Maximum	N
Family	All	32.85	2.929	30.000	16.67	75.00	23
Non-family	All	24.96	4.780	21.591	18.18	38.46	4
Family	Adult Male	35.45	4.702	34.375	18.18	50.00	7
	Adult Female	33.14	6.110	37.500	18.18	50.00	5
	Yearling Male	28.11	1.366	28.333	25.00	30.77	4
	Yearling Female	45.92	14.586	33.333	29.41	75.00	3
	Juvenile Female	38.10	0.000	38.100	38.10	38.10	1
	Kits	17.78	1.111	16.667	16.67	20.00	3
Non-family	Male	18.18	0.000	18.182	18.18	18.18	1
	Female	27.21	5.958	25.000	18.18	25.00	3

TABLE 7. Percent of activity occurring in the core area (core activity) in summer for Beavers, comparing all family and non-family animals (Mann Whitney U test), different age classes and sexes within family groups (Kruskal-Wallis Analysis of Variance) and males and females in the non-family group (Mann Whitney U test). Median values are not significantly different from each other ($p > 0.05$) (within each group — all Beavers, family only and non-family only).

Family Status	Age Class and Sex	Mean (%)	SE	Median	Minimum	Maximum	N
Family	All	74.68	1.411	77.200	60.89	84.40	25
Non-family	All	70.92	1.741	68.000	63.90	78.40	9
Family	Adult Male	74.12	2.877	77.800	64.50	81.40	7
	Adult Female	69.84	2.657	72.800	60.89	79.00	7
	Yearling Male	76.70	3.112	78.500	66.30	84.40	5
	Yearling Female	78.95	0.821	78.905	77.20	80.79	4
	Juvenile Female	79.96	4.125	79.955	75.83	84.08	2
Non-family	Male	70.64	3.146	71.150	63.90	76.34	4
	Female	71.15	2.224	68.000	67.33	78.40	5

TABLE 8. Percent of activity occurring in the core area (core activity) in fall for Beavers, comparing all family and non-family animals (Mann Whitney U test), different age classes and sexes within family groups (Kruskal-Wallis Analysis of Variance) and males and females in the non-family group (no statistical test, sample size too small). Median values are not significantly different from each other ($p > 0.05$) (within each group — all Beavers and family only).

Family Status	Age Class and Sex	Mean (%)	SE	Median	Minimum	Maximum	N
Family	All	76.97	2.098	78.500	53.50	95.40	24
Non-family	All	71.37	3.313	71.080	65.50	77.80	4
Family	Adult Male	78.14	1.668	75.600	73.10	84.90	7
	Adult Female	72.80	6.322	64.400	62.50	95.20	5
	Yearling Male	75.38	3.056	77.050	66.60	80.80	4
	Yearling Female	79.43	13.082	89.400	53.50	95.40	3
	Juvenile Female	79.20	0.000	79.200	79.20	79.20	1
	Kits	80.07	1.517	78.600	78.50	83.10	3
Non-family	Male	76.36	0.000	76.360	76.36	76.36	1
	Female	69.70	4.051	65.800	65.50	77.80	3

family animals (Mann-Whitney U test, $T = 233.5$, $p < 0.005$) (Table 1), but in fall there was no significant difference in size of family and non-family home ranges ($T = 78.5$, $p > 0.1$) (Table 2). Likewise, in summer, core areas of family Beavers were significantly smaller than those of non-family animals ($T = 211.5$, $p < 0.05$) (Table 3), but in fall the core area sizes did not differ between family and non-family animals ($T = 63$, $p > 0.1$) (Table 4). Core percent did not differ between family and non-family Beavers in summer ($T = 115.5$, $p > 0.1$) (Table 5) nor in fall ($T = 40.5$, $p > 0.1$) (Table 6). Neither did core activity differ between family and non-family animals in summer ($T = 120$, $p > 0.1$) (Table 7) or fall ($T = 38$, $p > 0.1$) (Table 8).

In summer there was a significant difference in home range size among the sex and age classes within the family group (Kruskal-Wallis ANOVA, $H = 9.559$, $df = 4$, $p < 0.05$) (Table 1). Multiple pairwise comparisons showed adult female home ranges to be significantly smaller than those of adult males (Dunn's Method, $p < 0.05$), but no other significant differences among the adults and yearling males, yearling females and juvenile females (Table 1). In fall there was no significant difference in home range size among the sex and age classes within the family group ($H = 8.618$, $df = 5$, $p > 0.1$) (Table 2). Core area size was similar for all sex and age classes in summer ($H = 9.388$, $df = 4$, $p > 0.05$) (Table 3). Although the Kruskal-Wallis ANOVA showed a significant difference in core area size in fall among the sex and age classes ($H = 13.445$, $df = 5$, $p < 0.05$), the subsequent Dunn's Multiple Comparison did not reveal any significant differences in the pairwise tests of the different sex and age classes (Table 4), possibly due to the small sample sizes. Core percent did not differ among the sex and age classes in both summer ($H = 5.824$, $df = 4$, $p > 0.1$) (Table 5) and fall ($H = 2.822$, $df = 5$, $p > 0.1$) (Table 6) and core activity did not differ among the sex and age classes in either summer ($H = 2.27$, $df = 4$, $p > 0.1$) (Table 7) or fall ($H = 7.803$, $df = 5$, $p > 0.1$) (Table 8) within the family group.

Discussion

The family Beavers in the Wallace Lake study area demonstrated smaller home ranges and core areas than non-family Beavers in summer, but there were no differences between the groups in the fall. The primary difference between Beavers living in family groups and those not living in families is the presence of kits in the family groups. Kits require nursing and the provision of solid food from outside the lodge, especially in the summer. This ties members of family groups to the lodge, and may restrict the degree to which they may roam freely from the lodge during the night. Non-family Beavers do not have this requirement of returning to the lodge during their nightly activities, and are therefore freer to

travel greater distances from the lodge during the night. In the fall, the obligate activities of family and non-family Beavers are more similar resulting in more similar home range sizes. Alternatively, or simultaneously, it may be that the better habitats are occupied by the family groups, and therefore the individual Beavers are left to use poorer habitat, which requires more movement in order to find food. Unattached Beavers may also be travelling further afield in search of a mate and suitable habitat for establishing a lodge and raising a family.

Within family groups, the adult female's home range was smaller than that of other family members in the summer, but otherwise there were no significant differences in home range size or patterns of use of the home range among the members of family groups. While I observed all the members of family groups apparently provisioning the lodge with food for the kits, the additional need for nursing, which only the adult female is capable, best accounts for the smaller adult female home ranges in summer. In contrast, in a comparison between adult male and adult female Beavers, Buech (1995) cited the adult male as spending more time in the lodge than the adult female in the summer, but also cited the adult male as spending more time travelling, while the adult female spent more time feeding. As in the present study, Buech (1995) found a greater similarity in behaviours between adult males and females in fall. Other studies have found adult males to have a great deal of summer movement (Tevis 1950; Townsend 1953). The role attributed to the adult male Beaver in raising the kits varies greatly, from little or no participation (Seton 1909; Bradt 1938; Busher 1975) to some or full participation (Brady and Svendsen 1981; Busher and Jenkins 1985; Buech 1995).

Most of the studies of Beaver behaviour have focussed on the adult members of family groups, so there is very little in the literature on the role and behaviours of juveniles, yearlings and kits. However, as I found for members of family groups, Tevis (1950) and Brady and Svendsen (1981) found that Beavers were independent of each other during the night. Busher and Jenkins (1985) showed that the behaviour of yearling females was more similar to that of adult females while that of yearling males was more similar to kits. This distinction between sexes among yearlings was not evident in the present study, but similarity of home range sizes and behaviours are not necessarily synonymous. As in the present study, Busher and Jenkins (1985) found that all family members except the kits had similar behaviour patterns in the fall. They also report that much more time was spent outside the rest site in fall (>80% of active time) than in summer (Busher and Jenkins 1985). The kits in this present study (fall data only), while not differing significantly from other family members in home range parameters, did tend to remain close to the lodge. As the smallest family

members, these kits are most susceptible to predation, and therefore likely remain closer to the lodge.

In summary, the greatest difference in Beaver home ranges is between those Beavers living in family groups, and those Beavers not residing in these family groups. These differences may reflect differences in obligate activities, habitat quality or behaviour. Within family groups, there is little difference in home range between the family members except for the smaller home range for adult females in summer. This probably relates to the different role that the adult female must play in raising the young.

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Beaver, *Castor canadensis*, Home Range Size and Patterns of Use in the Taiga of Southeastern Manitoba: III. Habitat Variation

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Differences in home range size among Beavers living in ponds, lakes and rivers were examined in southeastern Manitoba. Beavers living in river habitat had larger summer home ranges than those living in ponds ($p < 0.05$), but there were no differences between river and lake or pond and lake dwelling beavers ($p > 0.05$). However, when non-family Beavers were excluded from the analysis, there was no significant difference in home range size among the habitats ($p > 0.05$). Summer core areas were significantly smaller for pond Beavers than for river animals ($p < 0.05$) when non-family Beavers were included, but not when they were excluded from the analysis ($p > 0.05$), and there were no differences between pond and lake or river and lake animals ($p > 0.05$). In fall there were no differences in home range or core area size among the habitats ($p > 0.05$). The percent of the home range included in the core area did not differ among the habitats in summer or fall ($p > 0.05$). The percent of activity occurring in the core area did not differ among the habitats in summer, but in fall core activity was greater for lake than river Beavers regardless of whether non-family Beavers were included in the analysis ($p < 0.05$), but there were no differences between pond and river or pond and lake ($p > 0.05$).

Key Words: Beaver, *Castor canadensis*, habitat, boreal forest, home range, Manitoba.

Little is known about the home range size of Beavers, and especially how home range size relates to habitat. Much early work on Beavers relied on examining evidence of Beaver activity: lodges; dams; food piles; and cutting areas (Morgan 1868 *as cited in* Morgan 1986; Warren 1927). Only with the advent of radio-telemetry has the study of the actual movements of this nocturnal, semi-aquatic mammal been possible.

Davis (1984) found minima and maxima of movement to be different for stream and lake Beavers in South Carolina. Busher (1975) quantified daily movements of Beaver living in a stream habitat. Neither author delineated actual home range areas. Likewise, Brady and Svendsen (1981), Bergerud and Miller (1977) and Green (1936) all described Beaver activities without quantifying movements or home range size. Gillespie (1975) described smaller home range sizes for Beavers living in a pond as compared to lake habitat.

The traditional view of the Beaver is an animal living in a pond created by a Beaver dam which maintains a constant water level. In reality, many Beavers also live on free-flowing rivers and on lake shores. Beavers living in lake and river habitats are potentially subject to greater fluctuations in water level than those living in pond habitats, while those living in pond habitats have a requirement of greater effort on maintenance activity than river or lake Beavers. Therefore, the expectation was that there would be differences in the home range size and patterns of use among Beavers living in these three dif-

ferent habitats. In this paper I examine the differences in home range size and other home range characteristics demonstrated by Beavers living in pond, lake and river habitats within the boreal forest of eastern Manitoba.

Methods

The study area, methods of capturing, marking and tracking Beavers, and data manipulation are described in Wheatley (1997a). I classified Beavers as pond, lake or river Beavers based on the location of their primary residence, the lodge or bank burrow used most often, during each season. I defined ponds as areas of still water, created and maintained at a relatively constant level by a Beaver dam; lakes as larger areas of non-flowing water, without a dam; and rivers as areas of flowing water, without the presence of any Beaver dams.

I calculated home range size and core area size by totalling the number of grid cells in each (Wheatley 1997a). I calculated the percent of home range that was included in the core area for each Beaver, and refer to this as core percent. I calculated core activity as the percent of all observations that occurred within the core area. Family Beavers are those residing in a group with a breeding pair and kits, while non-family animals are solitary animals or if paired, not living in a lodge with a breeding pair and kits.

I analysed the data for all Beavers by habitat type. Since earlier analysis showed that season affected home range size and core area size (Wheatley 1997a), I analysed data only within each season.

TABLE 1. Summer home range size (ha) for Beavers living in pond, lake and river habitats for all Beavers and for family Beavers only. Median values followed by different letters are significantly different from each other ($p < 0.05$) (within each group — all Beavers and family only). All other comparisons within each group are not significantly different ($p > 0.05$).

Family Status	Habitat	Mean (ha)	SE	Median	Minimum	Maximum	N
All Beavers	Pond	6.54	0.642	6.625 ^a	2.50	12.50	14
	Lake	9.77	1.663	9.75	2.75	20.50	11
	River	16.94	4.004	13.75 ^b	2.25	42.75	9
Family only	Pond	6.19	0.513	6.625	2.50	8.25	12
	Lake	8.78	1.883	6.00	2.75	20.50	9
	River	10.06	2.923	11.00	2.25	16.00	4

Earlier analysis also showed that family status affected home range size (Wheatley 1997b), so I analysed habitat differences for all Beavers regardless of family status, and then separately for just family Beavers. I tested for differences between the habitats using the Kruskal-Wallis One Way Analysis of Variance, with subsequent multiple comparisons (Dunn’s Method) if the Kruskal-Wallis Test Statistic indicated a significant difference among the habitats (Conover 1980).

Results

I determined summer home range size for 34 Beavers (14 river, 11 lake and 9 pond) and fall home range size for 27 Beavers (6 river, 13 lake and 8 pond). All Beaver home ranges tended to follow shorelines, with movement across open water limited to travel directly from one shore to another. In summer, five of the river Beavers occupied home ranges which included lake areas. Three of these Beavers were non-family Beavers and include the two largest home ranges in the data set (42.75 ha and 26.75 ha). The other two were an adult breeding pair with a lodge near the river mouth. Beavers living in ponds did not necessarily remain within the boundaries of the pond, but frequently moved both downstream over their dam and upstream, crossing other dams above their home pond.

When all Beavers were considered, summer home range size was larger for Beavers living in rivers as compared to those living in ponds ($p < 0.05$) but there was no difference between pond and lake

($p > 0.05$) or lake and river home ranges ($p > 0.05$) (Table 1). When non-family Beavers were excluded from the analysis, there was no significant difference in summer home range size among the Beavers living in the different habitats ($p > 0.05$) (Table 1). Similarly, when all Beavers were considered, summer core areas were larger for river Beavers than for those living in ponds ($p < 0.05$), but there was no difference between pond and lake or lake and river Beavers ($p > 0.05$) (Table 2). Again, when non-family Beavers were excluded from the analysis, there was no significant difference in summer core area among Beavers in the different habitats ($p > 0.05$) (Table 2). The percent of the home range area included in the core area did not differ among the Beavers ($p > 0.05$) (Table 3) in summer and neither did the percent of activity occurring in the core area differ among the Beavers from different habitats ($p > 0.05$) (Table 4).

In fall, there was no significant difference among the Beavers living in different habitats for home range size ($p > 0.05$) (Table 5), core area size ($p > 0.05$) (Table 6) or percent of home range included in the core area ($p > 0.05$) (Table 7) whether all Beavers were included or when only family Beavers were included in the analysis. Fall core activity was greater for lake Beavers than for river Beavers ($p < 0.05$) regardless of whether non-family Beavers were included in the analysis (Table 8). There was no significant difference in core activity between pond and river ($p > 0.05$) animals or pond and lake animals ($p > 0.05$) (Table 8).

TABLE 2. Summer core area size (ha) for Beavers living in pond, lake and river habitats for all Beavers and for family Beavers only. Median values followed by different letters are significantly different from each other ($p < 0.05$) (within each group — all Beavers and family only). All other comparisons within each group are not significantly different ($p > 0.05$).

Family Status	Habitat	Mean (ha)	SE	Median	Minimum	Maximum	N
All Beavers	Pond	1.86	0.194	1.75 ^a	0.75	3.00	14
	Lake	2.32	0.337	2.00	0.75	4.00	11
	River	4.83	1.434	3.25 ^b	0.75	14.25	9
Family only	Pond	1.83	0.191	1.75	0.75	3.00	12
	Lake	2.08	0.354	2.00	0.75	4.00	9
	River	2.94	0.786	3.25	0.75	4.50	4

TABLE 3. Percent of the home range area included in the core area (core percent) in summer for Beavers living in pond, lake and river habitats for all Beavers and for family Beavers only. Median values are not significantly different from each other ($p > 0.05$) (within each group — all Beavers and family only).

Family Status	Habitat	Mean (%)	SE	Median	Minimum	Maximum	N
All Beavers	Pond	28.55	1.418	28.16	21.05	37.50	14
	Lake	25.15	1.339	25.00	18.96	33.33	11
	River	27.69	2.366	28.13	16.36	35.51	9
Family only	Pond	29.55	1.448	30.15	23.08	37.50	12
	Lake	25.45	1.426	25.00	19.51	33.33	9
	River	30.42	1.993	30.73	26.00	34.21	4

TABLE 4. Percent of all activity occurring in the core area in summer (core activity) for Beavers living in pond, lake and river habitats for all Beavers and for family Beavers only. Median values are not significantly different from each other ($p > 0.05$) (within each group — all Beavers and family only).

Family Status	Habitat	Mean (%)	SE	Median	Minimum	Maximum	N
All Beavers	Pond	74.54	2.067	76.52	60.90	84.40	14
	Lake	74.34	2.006	76.34	60.89	80.67	11
	River	71.55	1.790	68.00	66.66	80.79	9
Family only	Pond	75.11	2.211	76.52	60.90	84.40	12
	Lake	74.12	2.467	78.50	60.89	80.67	9
	River	74.65	2.980	75.30	67.20	80.79	4

TABLE 5. Fall home range size (ha) for Beavers living in pond, lake and river habitats for all Beavers and for family Beavers only. Median values are not significantly different from each other ($p > 0.05$) (within each group — all Beavers and family only).

Family Status	Habitat	Mean (ha)	SE	Median	Minimum	Maximum	N
All Beavers	Pond	2.69	0.523	2.50	1.00	5.25	8
	Lake	2.65	0.457	2.50	2.75	20.50	13
	River	4.50	0.922	3.50	2.75	8.00	6
Family only	Pond	2.69	0.523	2.50	1.00	5.25	8
	Lake	2.46	0.449	2.00	1.00	6.50	12
	River	5.00	1.561	2.00	2.75	8.00	3

TABLE 6. Fall core area size (ha) for Beavers living in pond, lake and river habitats for all Beavers and for family Beavers only. Median values are not significantly different from each other ($p > 0.05$) (within each group — all Beavers and family only).

Family Status	Habitat	Mean (ha)	SE	Median	Minimum	Maximum	N
All Beavers	Pond	1.00	0.222	0.405	0.50	2.75	8
	Lake	0.73	0.118	0.500	0.25	1.50	13
	River	1.33	0.427	0.875	0.50	2.75	6
Family only	Pond	1.00	0.222	0.405	0.50	2.75	8
	Lake	0.69	0.120	0.500	0.25	2.00	12
	River	1.50	0.661	1.250	0.50	2.75	3

TABLE 7. Percent of home range area included in the core area in fall for Beavers living in pond, lake and river habitats for all Beavers and for family Beavers only. Median values are not significantly different from each other ($p > 0.05$) (within each group — all Beavers and family only).

Family Status	Habitat	Mean (%)	SE	Median	Minimum	Maximum	N
All Beavers	Pond	40.33	6.137	37.80	20.00	75.00	8
	Lake	28.91	3.011	26.67	16.67	50.00	13
	River	26.13	3.743	23.80	18.18	38.46	6
Family only	Pond	40.33	6.137	37.80	20.00	75.00	8
	Lake	29.24	3.254	28.33	16.67	50.00	12
	River	27.32	4.790	29.41	18.18	34.38	3

Discussion

Beaver home ranges are not uniform in size and do not conform to any regular shape. Rather, the home ranges follow the convoluted shorelines of lakes, the meandering routes of rivers, or the natural, irregular outlines of ponds. Shorelines are the primary source of Beaver food, either the leaves and bark of terrestrial trees or the aquatic plants growing in shallow water near the shore (Jenkins and Busher 1979).

When moving between feeding sites and lodges, Beavers tended to stick close to shore. Tevis (1950) also reported frequent movement by Beavers along shorelines. The eyesight of Beavers is poor compared to their senses of smell and hearing (Jenkins and Busher 1979). By travelling near the shore they may be better able to track their location by smell. Similar movement patterns, in which the animals stay close to the shore and avoid deep water, except to cross, have been reported for other semi-aquatic species such as Nile Crocodiles (*Crocodilus niloticus*) (Hutton 1989) and Snapping Turtles (*Chelydra serpentina*) (Galbraith et al. 1987). While tracking their location by smell might be expected on the river, it seems unusual on the lake or ponds, but by remaining near the shore the Beavers are able to maintain a reference point for as long as possible.

In summer, river home ranges were larger than pond home ranges, and river core areas were larger than pond core areas. However, this habitat difference disappeared when non-family Beavers were

excluded from the analysis. Earlier research had shown a significant difference between the size of family and non-family home ranges and core areas (Wheatley 1997b). Whether this difference in home range and core area sizes is directly due to the prevalence of non-family Beavers in river habitat, or whether, instead, it is due to characteristics of the habitat occupied by these non-family Beavers is difficult to assess. River habitat in the study area was bordered by numerous bogs containing Black Spruce (*Picea mariana*), Jack Pine (*Pinus banksiana*), Alder (*Alnus crispa*) and Tamarack (*Larix laricina*), with a few ridges containing Jack Pine and Trembling Aspen (*Populus tremuloides*). Lakes and ponds tended to have more numerous ridges and fewer bogs along their shores. Trembling Aspen is a favoured food of Beavers (Jenkins and Busher 1979), and there was a greater abundance of Trembling Aspen along lake and pond shores than along river banks. Any better quality habitat along the river was likely already occupied by established Beaver families. This leaves the poorer quality habitat for the less settled or potentially transient non-family Beavers. If these Beavers then had to travel farther in search of food, this may account for the larger home ranges. But, this poorer quality habitat in terms of food, also provides the softer banks necessary for bank burrows. The rockier lake shores afford little opportunity to build bank burrows. Most of the non-family Beavers were juveniles (Wheatley 1997b), in the process of seeking a mate and a site for establishing their own family

TABLE 8. Percent of all activity occurring in the core area (core activity) in fall for Beavers living in pond, lake and river habitats for all Beavers and for family Beavers only. Median values followed by different letters are significantly different from each other ($p < 0.05$) (within each group — all Beavers and family only). All other comparisons within each group are not significantly different ($p > 0.05$).

Family Status	Habitat	Mean (%)	SE	Median	Minimum	Maximum	N
All Beavers	Pond	75.44	3.941	75.25	62.50	95.40	8
	Lake	81.12	1.532	78.60 ^a	75.60	95.20	13
	River	66.28	3.269	65.65 ^b	53.50	76.36	6
Family only	Pond	75.44	3.941	75.25	62.50	95.40	8
	Lake	81.39	1.638	79.70 ^c	75.60	95.20	12
	River	63.33	5.658	63.40 ^d	53.50	73.10	3

base. A bank burrow, many of which already existed along the river, provides a dwelling that uses less energy to establish and maintain, especially if the likelihood of establishing permanent residence at the site is limited. So while not providing a high quality habitat in terms of food, rivers may provide an optimum habitat when both food and shelter are considered. At the same time, the regular movements of these Beavers might be expected to range more widely in search of a suitable site for colonization. The larger home ranges in this group of Beavers likely are a combination of this searching behaviour of juvenile animals and the characteristics and quality of the habitat available to them.

While the river in this study may generally be classed as providing poorer quality habitat, it would be expected that Beaver ponds, which require a greater energy input for maintenance of the dam, would provide better quality habitat. I hypothesize this because there would seem to be a need for a certain quality of habitat in order to justify the extra effort necessary for building and/or maintaining a dam. If this higher quality of pond habitats is reflected by a greater abundance of food (including aquatic plants which may be eaten by Beavers (Jenkins 1979)), then pond Beavers should be able to obtain sufficient food while occupying smaller home ranges. Similarly if food is more concentrated, core areas should be smaller. However, home ranges of family Beavers living in ponds in this study were not different from lake or river Beavers. In contrast with my findings, Gillespie (1975) reports much smaller home ranges for the pond Beavers she observed as compared to the lake Beavers. Gillespie's (1975) estimates of home range size for the period of June to October were much smaller than my estimates for pond Beavers (1.76 ha) but larger than my estimates for lake Beavers (15.0 ha).

The quality of the habitat may not just be reflected in the abundance of food. Ponds may also provide better protection from predators and a more secure habitat in terms of water levels. While a pond has an area that is more definitively delineated than the river or lake, the pond Beavers in this present study did not always remain within the boundaries of their own pond. In contrast, Tevis (1950) found Beavers were restricted to their own pond. This may be dependent on the density of Beavers in the area. Because there were no other Beavers living in the immediate vicinity of the pond Beavers I studied, there were no potential territorial limits from neighbouring Beavers. The ponds also had a long history of Beaver occupation (over 20 years, Bill Conley, personal communication). This may have reduced the quality of the habitat in terms of food availability, resulting in the need to travel farther to find food, while maintaining the other benefits of pond residence. So, while initially ponds might be expected to be associated with smaller home ranges and core

areas, this relationship does not seem to extend to older ponds if food availability decreases.

Similarly to the ponds, many of the lodges on the river had been occupied for many years. In contrast to the river and pond Beavers, lake Beavers generally occupied newly constructed lodges, in areas where there was little evidence of previous Beaver activity. Because the areas had not been subject to previous harvesting by Beavers, food was likely denser in these areas, resulting in more concentrated activity and explaining the higher value of fall core activity for lake Beavers. Buech (1995) has also hypothesized that differences between habitats in the time spent on different types of behaviour may account for differences in home range size and apparent patterns of use.

Although there are some small differences between the habitats in patterns of home range use, the relative similarities between the three habitats were surprising. One final explanation for these similarities may be the forest fire history of the area. The entire study area was burnt in May, 1980, six years before the start of this study. While the intensity of the forest fire varied across the study area, all the locations where I studied Beavers were affected to some extent. The short period between the time of the fire and the study may mean that there was little time for differentiation between the habitats, which were all still in the early successional stages throughout this study. As succession proceeds at different rates in different locations throughout the region, habitats may become more distinct and differences in Beaver home ranges more apparent. But, because forest fires are a natural part of succession in the boreal forest, it may be that the lack of differentiation between habitats is the more common scenario within the boreal regions.

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Food Preference and *ad libitum* Intake of Wild-captured Sitka Mice, *Peromyscus keeni sitkensis*

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Food preferences of Sitka Mouse (*Peromyscus keeni sitkensis*) were studied in four experiments involving fruits from five major shrub species and seeds from three tree and four shrub species. Each experiment consisted of individual animals being offered mixed-species assortments of foods fed over a four-day period. *Ad libitum* intake trials were conducted with the same foods used in the preference experiments but with only one food per trial. Intake trials also included beetles (*Seaphinotus* and *Pterostichus* spp.) and Pink Salmon (*Oncorhynchus gorbuscha*). Salmonberry (*Rubus spectabilis*) and Stink Current (*Ribes bracteosum*) fruit and seeds emerged as highly preferred and valuable foods in terms of both relative preference and *ad libitum* intake. Devilsclub (*Oplopanax horridus*) and Elderberry (*Sambucus racemosa*) fruits were least preferred in both preference and intake, although their seeds were relatively palatable and nutritious (in terms of weight loss). Blueberry (*Vaccinium ovalifolium*) fruit was intermediate in both preference and intake. Tree seed palatability and intake ranked in order of Sitka Spruce (*Picea sitchensis*) (highest), Western Hemlock (*Tsuga heterophylla*), and Red Alder (*Alnus rubra*) (lowest). *Ad libitum* intake of beetles was low, and that of Pink Salmon was near zero. These results should be helpful in interpreting diet composition studies of Sitka Mouse throughout its range and possibly other *Peromyscus* species in wet coastal forests of the Pacific Northwest and Alaska.

Key Words: Sitka Mouse, *Peromyscus keeni sitkensis*, diet choice, diet selection, voluntary intake, food habits, Alexander Archipelago, Alaska.

The Sitka Mouse (*Peromyscus keeni sitkensis*) is endemic to the outer-coast islands of the Alexander Archipelago of southeastern Alaska and to the Queen Charlotte Islands, British Columbia (Swarth 1911; Nagorsen 1990). Until recently, it was considered a separate species (*P. sitkensis*), Hogan et al. (1993), however, have proposed that it and the Deer Mouse (*P. maniculatus*) in southeastern Alaska and northern British Columbia coast as well as the Columbian Mouse (*P. oreas*) of northern Vancouver Island and vicinity are all subspecies of Keen's Mouse (*P. keeni*). The Sitka Mouse inhabits temperate, coniferous rain forest and associated habitats within the Western Hemlock-Sitka Spruce (*Tsuga heterophylla* – *Picea sitchensis*) forest type (Ruth and Harris 1979). Its distribution and population ecology have seldom been studied, and even less is known of its feeding ecology. Like others of the *Peromyscus* genus (Van Horne 1982), however, its diet is one of mostly seeds, supplemented with insects and other invertebrates (T. A. Hanley, J. C. Barnard, and M. Ben-David, U.S. Forest Service and University of Alaska, unpublished data).

Food preference experiments, where differential availability of foods is not a factor, have never been reported for the Sitka Mouse or any other *Peromyscus* species living in similar habitats. Therefore, we studied food preferences and *ad libi-*

tum intake of major summer foods of the Sitka Mouse under controlled conditions.

Methods

The study was conducted during July and August, 1995, at the Kadashan River field station on Chichagof Island, southeastern Alaska (57° N, 135° W). Animals were captured as needed, using Longworth traps baited with rolled oats. Traplines were in Sitka Spruce floodplain, mature Red Alder (*Alnus rubra*) floodplain, and old-growth Western Hemlock-Sitka Spruce upland forests (Hanley and Hoel 1996). All juveniles (based on pelage coloration) and pregnant or lactating females were released; we used only nonbreeding adults. Mice were maintained individually in separate 40 × 38 × 30-cm plywood boxes with a screen top and an aluminum bottom liner to facilitate cleaning. Each box contained a water bottle, steel nest box (9 × 14 × 8 cm) filled with polyester bedding, and set of feeding stations. Mice were fed a millet-based bird seed mixture during non-trial periods and were allowed a minimum of one week to adjust to captivity before being used in a feeding trial. Feeding stations constructed of plywood with sheet aluminum dividers and a raised floor of hardware cloth allowed simultaneous presentation of 1-4 foods in 1/2-pint (240-ml) wide-mouth Mason jars while min-

imizing spillage and mixing. Fresh food was presented and the orts collected each day for four consecutive days. Dry matter was determined for each food (100° C for 24 hrs, measured with a Mettler balance to 0.01 g) and multiplied by wet weight to determine dry weight offered. Feces were removed, and orts were dried also. Animals were weighed daily (with an Avinet spring scale to 0.5 g), and a trial for any given animal was discontinued if that animal lost more than 25 percent of its initial body weight. We followed the American Society of Mammalogists' (1987) care protocol.

Relative preferences were analyzed in four separate experiments of two to four foods each. All 12 foods could not be fed simultaneously for the following reasons: (1) their availability changed throughout the summer, so all were not simultaneously available; (2) we could not harvest sufficient quantities of more than three or four foods at a time; and (3) the number of mice needed for statistical analysis was estimated to be 3 × the number of foods in an experiment (Roa 1992). We used a total of 17 mice (6 males, 11 females). Some mice were used in several experiments, others were used in only one. Mice were selected on the basis of appearing healthy and in good body condition. Each experiment was conducted and analyzed independently. Therefore, relative preferences could be determined within experiments but not between experiments.

Selection of offered foods was based on the timing of their local availability and our ability to collect sufficient quantities. Foods were grouped in similar-kind trials (fruits, tree seeds, fruit seeds)

accordingly. Fresh fruit was collected daily for fruit trials. Seeds of Sitka Spruce, Western Hemlock, and Red Alder were separated from their cones by a mechanical separator. Fruit seeds were obtained by crushing, screening, and washing ripe fruits.

Nine mice were used in Experiment 1, which involved fresh fruits: Salmonberry (*Rubus spectabilis*), Blueberry (*Vaccinium ovalifolium*), and Elderberry (*Sambucus racemosa*) (14-17 July). Six mice were used in Experiment 2, which also involved fresh fruits: Stink Current (*Ribes bracteosum*) and Devilsclub (*Oplopanax horridus*) (28-31 July). Nine mice were used in Experiment 3, which involved tree seeds: Sitka Spruce, Western Hemlock, and Red Alder (4-8 August). And 12 mice were used in Experiment 4, which involved seed cleaned from fruit: Salmonberry, Elderberry, Stink Current, and Devilsclub (25-28 August) (Blueberry seeds were too small to include).

Ad libitum intake trials were conducted with three or four mice (depending on our ability to harvest food) for each food during the week immediately following the respective preference experiment. Each food was fed separately. Additionally, intake trials were conducted with fresh and partially decayed Pink Salmon (*Oncorhynchus gorbuscha*) and various species of live beetles captured in pitfall traps (predominantly *Seaphinotus angusticollis* with a few *Pterostichus crenicollis* and *P. castaneus*).

The preference experiments were analyzed with multivariate analysis of variance as suggested by Roa (1992). Total dry-matter intake of each food by each mouse over the 4-day trial was divided by the

TABLE 1. Mean dry-matter intake (total four-day intake divided by mean body weight, for each mouse) and mean change in body weight (grams) in four preference experiments. N = Number of mice. SD = Standard deviation. P = Probability of null hypothesis, multivariate analysis of variance.

Experiment/Food	Mean dry-matter intake	SD	P	Mean body weight change	SD
Experiment 1 (N = 9)			0.000	-3.67	2.70
Salmonberry fruit	0.380	0.061			
Blueberry fruit	0.069	0.038			
Elderberry fruit	0.007	0.044			
Experiment 2 (N = 4)			0.009	-5.75	3.16
Stink Current fruit	0.161	0.035			
Devilsclub fruit	0.077	0.015			
Experiment 3 (N = 9)			0.000	-0.94	2.86
Spruce seed	0.223	0.044			
Hemlock seed	0.094	0.051			
Alder seed	0.012	0.028			
Experiment 4 (N = 12)			0.000	1.75	3.47
Devilsclub seed	0.214	0.065			
Salmonberry seed ^a	0.098	0.043			
Elderberry seed ^a	0.078	0.048			
Stink Current seed	0.011	0.013			

^aFoods with same superscript do not differ from one another at alpha = 0.05.

TABLE 2. Mean *ad libitum* dry-matter intake (grams per day divided by mean body weight, for each mouse) and daily body weight change (grams) while on single foods during three- to four-day trials. N = number of mice in trial. Mean intake values with same superscript do not differ at the alpha level of 0.05, analysis of variance.

Food	N	Mean dry-matter intake	Mean weight change
Salmonberry fruit	4	0.138 ^a	-0.70
Stink Current fruit	4	0.108 ^{a,b}	-1.82
Salmonberry seed	3	0.092 ^{a,b,c}	-1.13
Stink Current seed	3	0.090 ^{a,b,c}	-1.92
Elderberry seed	3	0.089 ^{a,b,c}	-0.46
Spruce seed	4	0.084 ^{b,c}	-0.47
Hemlock seed	4	0.078 ^{b,c}	-0.41
Alder seed ¹	3	0.064 ^{b,c,d}	-2.72
Devilsclub seed	3	0.061 ^{b,c,d}	-0.67
Blueberry fruit ¹	3	0.057 ^{b,c,d}	-2.50
Beetles	3	0.050 ^{c,d,e}	-2.39
Salmon (rotten)	4	0.021 ^{d,e}	-2.47
Elderberry fruit	3	0.017 ^{d,e}	-1.56
Devilsclub fruit	4	0.015 ^{d,e}	-1.63
Salmon (fresh) ²	4	0.000 ^e	-3.07

¹One animal with only two days in trial is included in the alder seed trial and in the blueberry fruit trial.

²Two animals with only two days in trial are included in the fresh salmon trial.

individual’s average body mass to standardize for differences in body mass. MANOVA and Tukey’s test statistic (Wilkinson et al. 1992) were used to determine statistically significant differences in means. Results of *ad libitum* intake trials were compared using ANOVA and Tukey’s test. An alpha level of 0.05 was used for all statistical tests and comparisons. All mice were released upon completion of the study.

Results and Discussion

Mean pretrial body weight of all mice in all preference experiments and intake trials was 32.1 g (SD = 4.2). Most animals (73 of 90) lost weight during all experiments and trials, which is common when captive animals are fed single- or few-species rations of natural foods. Two of the six mice in Experiment 2 lost >25% body weight and were dropped from the four-day trial. All other mice completed their four-day trials in each of the other experiments. Significant differences in mean intakes (MANOVA) occurred in all four preference experiments, and all foods differed significantly from each other (Tukey’s test) in all experiments except Experiment 4 where Salmonberry seed and Elderberry seed did not differ (Table 1). Among fruits, Salmonberry was clearly most preferred and Elderberry least preferred. Interestingly, however, Devilsclub was the most highly preferred seed and Stink Current the least preferred seed (Experiment 4), which was exactly the opposite order of their preferences as fruits (Experiment 2). Among tree seeds, Sitka Spruce was most highly preferred and Red Alder least preferred (Experiment 3).

Mice were restricted to only one food in the intake

trials and lost weight much more quickly than in the preference experiments (Table 2). In 16 instances, intake trials were terminated after only three days, and in four instances after two days. Rather than discard these data, results were expressed as mean daily intake rather than total trial intake, and all mice with ≥ 2 days of data were included. Food intakes were significantly different (P < 0.05; Table 2). Greatest daily intakes were of Salmonberry and Stink Current fruit and seed, while lowest intakes were of Pink Salmon, Devilsclub fruit, Elderberry fruit, and beetles. *Ad libitum* intake is a function of at least two counteracting variables: palatability and nutritional quality (Robbins 1993). High palatability should result in high intake, but high intake could also result from low nutritional value as animals are forced to eat more food to maintain nutritional balance. It is impossible to determine cause-and-effect in such simple trials.

Salmonberry and Stink Current fruits were highly preferred in the preference experiments and were consumed in greatest quantity in the intake trials. Salmonberry, however, appears to be nutritionally superior to Stink Current in terms of mice weight loss (Tables 1 and 2). Seeds resulted in less weight loss than did fruits in the other species. Both Devilsclub and Elderberry, especially, appeared to be both more highly palatable and nutritious as seeds than as fruits in both preference experiments and intake trials. Red Alder seeds were the least preferred of the tree seeds, and animals lost substantial weight when forced to eat them in the intake trials.

Although Pink Salmon were not used in preference experiments, the extremely low intake of Pink

Salmon and high weight losses of mice on Pink Salmon in the intake trials indicate that Pink Salmon probably are not eaten by mice in the field. That also is consistent with stable isotope analysis (^{13}C and ^{15}N) of riparian food webs in our study area (M. Ben-David, University of Alaska, unpublished data). Pink Salmon carcasses scattered along the streams and throughout the riparian forests by bears, eagles, and other animals are readily available to mice throughout much of each summer. We had expected that they might provide a protein-rich food source for the generalist-feeding Sitka Mouse at that time.

Studies that quantify diet composition in terms of broad categories such as fruit and seeds, insects, etc., do not take into account the wide variation in palatability, voluntary intake, and nutritional value of food types and species. Field studies, regardless of detail, also are subject to differential availability of foods. Our study helps to identify the relative priorities of major foods in terms of feeding behavior by the Sitka Mouse. Although our preference experiments and intake trials provide insight into only a small part of the feeding ecology of the Sitka Mouse, they should be useful in interpreting field data from other studies throughout the species' range and possibly also that of other *Peromyscus* species in similar habitats.

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Summer Food Habits and Population Density of Coyotes, *Canis latrans*, in Boreal Forests of Southeastern Québec

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The Coyote (*Canis latrans*) arrived on the Gaspé peninsula in the mid 1970s. The population increased through 1990 followed by a general decline. We compared summer food habits of the Coyote in 1988 and 1991 in central Gaspé peninsula, a forested area dominated by conifers. We analyzed 231 scats in 1988 and 435 scats in 1991 to determine Coyote food habits. In 1991, we also marked seven Coyotes with radio-collars and a radioactive isotope (⁶⁵Zn) to estimate population density in the study area. The density estimate of 0.2 - 0.3 Coyote/10 km² (± 35 - 36%) was among the lowest ever recorded. Woodchuck (*Marmota monax*) and White-tailed Deer (*Odocoileus virginianus*) dominated the diet in May-June 1988 but were replaced by Moose (*Alces alces*), Snowshoe Hares (*Lepus americanus*) and Beavers (*Castor canadensis*) in 1991. Berries were preferred in mid-summer and comprised 56% and 80% of the volume of scats in August of 1988 and 1991, respectively. The use of small mammals remained relatively constant during both years; i.e., 9 - 19% of scat volume. Results are related to levels of prey abundance on the Gaspé peninsula.

Les coyotes (*Canis latrans*) sont arrivés dans la péninsule gaspésienne au milieu des années 1970. La population a connu une expansion jusqu'en 1990, suivi d'un déclin général. Nous avons comparé le régime alimentaire estival du Coyote en 1988 et 1991 dans la région centrale de la péninsule gaspésienne qui est dominée par les forêts conifériennes. Pour ce faire, nous avons analysé le contenu de 231 fèces récoltées en 1988 et de 435 fèces en 1991. En 1991, nous avons aussi marqués 7 coyotes avec un collier-émetteur et un isotope radioactif (⁶⁵Zn) pour estimer la densité de la population de l'aire d'étude. La densité de cette population, estimée à 0,2 - 0,3 coyote/10 km² (± 35-36%), était parmi les plus faibles jamais observées. Les principales proies utilisées en mai-juin 1988 étaient la marmotte (*Marmota monax*) et le cerf de Virginie (*Odocoileus virginianus*), mais ces proies furent remplacées par l'orignal (*Alces alces*), le lièvre d'Amérique (*Lepus americanus*) et le castor (*Castor canadensis*) en 1991. Les petits fruits étaient préférés au milieu de l'été, représentant jusqu'à 56% du volume des fèces en août 1988 et 80% en août 1991. L'utilisation des petits mammifères est restée relativement stable durant les deux années, variant entre 9 et 19% du volume. Ces résultats sont discutés en relation avec l'abondance des proies dans la péninsule gaspésienne.

Key Words: Eastern Coyote, *Canis latrans*, summer diet, population density, Québec.

The Coyote (*Canis latrans*) is as an adaptable carnivore that changes its diet in response to seasonal food availability (Todd et al. 1981; Van Vuren and Thompson 1982; Barrett 1983; Bowyer et al. 1983; Harrisson and Harrisson 1984; Parker 1986; Andelt et al. 1987; MacCracken and Hansen 1987; Dibello et al. 1990). This flexible behaviour has helped the Coyote expand its range following European settlement in North America. Coyotes arrived on the Gaspé peninsula in southeastern Québec in mid 1970s and were well established in the mid 1980s (Crête and Lemieux 1994*). Eastern Coyotes are larger than other conspecifics and may hunt during winter in family unit, enabling them to kill larger prey (Harrisson 1992; Larivière and Crête 1992). Consequently, two species of ungulates on the Gaspé peninsula have been seriously impacted by Coyotes.

The decline of White-tailed Deer (*Odocoileus virginianus*) in the Gaspé peninsula between 1986 and 1991 was attributed to a series of harsh winters. Mortality from starvation was nevertheless enhanced by Coyote predation (Pouille et al. 1993; Crête and Lemieux 1994*). Most large winter deer yards were unoccupied by 1992 and the hunting season was closed (Crête and Lemieux 1994*). After the deer crash, Coyotes also declined on the Gaspé peninsula (Crête and Lemieux 1994*).

Coyotes also threatened the last population of Caribou (*Rangifer tarandus*) which remained on the mainland east of the Fleuve Saint-Laurent: the Gaspésie Park Caribou herd (Crête et al. 1990; Crête and Desrosiers 1995). From 1984 to 1988, summer mortality of calves approached 90% and most mortalities were from Coyote predation (Crête and Desrosiers 1995). Black Bears (*Ursus americanus*) also killed calves, but most bears in the area apparently avoided the alpine tundra occupied by Caribou (Boileau et al. 1994). Dumont (1993), however,

*see Documents Section preceding Literature Cited.

observed that the presence of hikers in alpine tundra of the Gaspésie Park disturbed females with calves and forced them to enter forested habitats where they were more vulnerable to predation. The removal of Coyotes and bears after 1990 and the control of visitor access since 1992, have helped to increase the survivorship of calves (Crête and Desrosiers 1995).

Although many aspects of Coyote ecology and population dynamics in northeastern North America have been studied (*see* Boer 1992 and Parker 1995), little is known of its ecology in eastern boreal forests. The boreal forest is probably a marginal habitat for Coyotes and White-tailed Deer, as both species are at the northern limits of their range. More knowledge on the ecology of Coyotes is necessary to understand Coyote-prey relationships in that biome. Poulle et al. (1995) examined the fecundity and the seasonal variations in body reserves of Coyotes from the Gaspé peninsula. In this study, we report on the summer food habits of Coyotes in 1988, when numbers peaked on the Gaspé peninsula, and in 1991, after Coyotes began to decline. We also estimated the density of Coyotes in boreal forests in the centre of the Gaspé peninsula during 1991.

Study Area

The study area included parts of Gaspésie Conservation Park (GCP) and the Chic-Chocs Game Reserve (CCGR), in the centre of the Gaspé peninsula ($\approx 49^{\circ}00'N$, $66^{\circ}00'W$). Topography is rugged, with the McGerrigle Mountains forming an elevated plateau dominated by the Mont Jacques-Cartier (1270 m). At low elevation, forests are dominated by Balsam Fir (*Abies balsamea*), Paper Birch (*Betula papyrifera*) and Black Spruce (*Picea mariana*). At higher elevation in GCP, alpine tundra occupies wind-exposed sites and Black Spruce and Balsam Fir krummholz grow in protected areas. No logging, hunting or trapping has occurred in GCP since 1977. These activities persist in CCGR. A network of gravel roads covers most of GCP and CCGR at low elevation, but only a few hiking trails provide access to the alpine areas. The climate is continental with a mean yearly temperature below $0^{\circ}C$ (Gagnon 1970*). Annual precipitation averages 1663 mm on Mont Logan (1128 m altitude), including a snow fraction of 33%; snow cover persists from early October to early June. Near sea level, precipitation is 854 mm with a snow fraction of 32%; snow covers the ground from late November to early May.

Methods

Population density

The density of Coyotes was estimated in a 660 km^2 capture area in CCGR (Figure 1). We avoid biased estimates by maintaining sufficient dis-

tance ($\approx 10\text{--}20 \text{ km}$) from where Coyotes were removed in GCP to reduce predation on Caribou. Coyotes were captured in May-June 1991 using modified foot-hold traps. Seven Coyotes were fitted with radiocollars and injected intramuscularly with 2.2 MBq radioactive solution of ^{65}Zn . In July 1991, scats were collected on roadsides in the capture area. The proportion of radioactive scats was determined using a NaI detector with a multichannel analyzer (*see* Jolicoeur et al. 1993). The number of marked coyotes in the capture area was determined by locating the radiocollared animals from a helicopter in late June. Of the seven marked Coyotes, five were located in the capture area. We could not determine if the two remaining individuals had left the area or if their transmitters failed. Therefore, two estimates of population density were made, one which assumed that all marked Coyotes were still in the capture area in July, and the other that assumed five of seven marked Coyotes were in the area. The size of the Coyote population was estimated from the proportion of radioactive scats (Lancia et al. 1994) by using a Petersen Index (modified by Bailey (1951) in Caughley (1977)).

Food habits

Coyote scats were searched along gravel roads once every two or three weeks from June to August 1988 and from May to October 1991. Other scats were collected opportunistically around trapping sites in both CCGR and GCP. No effort was made to collect scats on the plateau used by caribou due to lack of access. Scats were oven-dried at $70^{\circ}C$ for 24 hours to kill parasites and then washed through a 2 mm sieve. Non-digested remains were collected, different items were separated, identified and their volume in each scat was visually estimated. Mammal hairs were identified using the pigment patterns of the medulla and the morphology of cuticular scale (Adorjan and Kolenosky 1969). A reference collection served to identify hairs, bones, berries and vegetation. Comparison between 1988 and 1991 was performed on a monthly basis with the Mann-Whitney U test on the mean volume per scat.

Results

Population density

In July 1991, 62 scats were collected in the capture area of which 19 contained the radioactive marker. Assuming that all marked Coyotes occupied the area, population size was estimated at 22 ± 8 individuals ($\pm 95\%$ confidence intervals); i.e., 0.3 Coyote/ 10 km^2 . If only five of the seven marked Coyotes stayed in the capture area, population size was estimated at 16 ± 6 individuals or 0.2 Coyote/ 10 km^2 .

Food habits

Monthly scat collection was not uniform. In 1988,

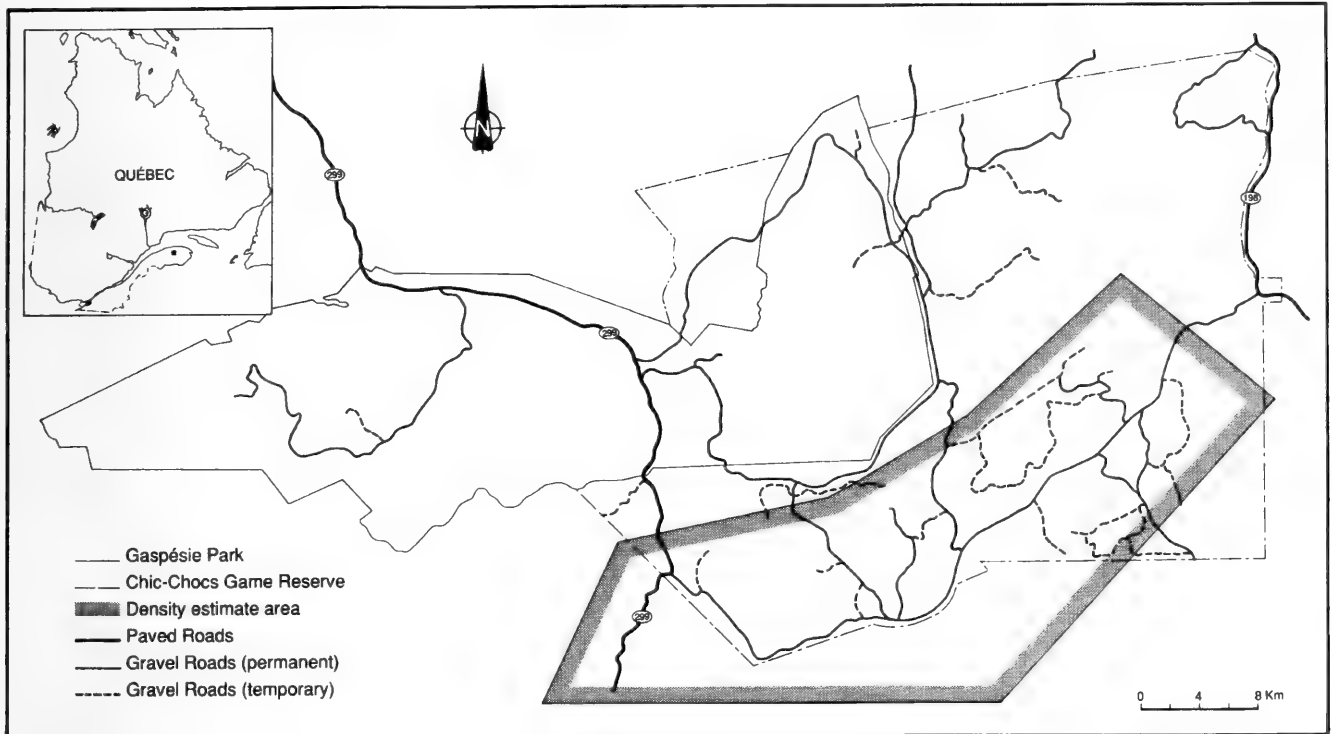


FIGURE 1. Location of Gaspésie Conservation Park and Chic-Chocs Game Reserve in southeastern Québec, showing the area where Coyote population density was estimated.

15 scats were collected in June, 50 in July and 166 in August. In 1991, scats were collected in May ($n=73$), June ($n=29$), July ($n=125$), August ($n=74$), September ($n=125$) and October ($n=19$).

The use of Woodchuck (*Marmota monax*) and deer declined from June to August 1988, passing from 34% and 16% to 10% and 0.5% of volume respectively (Figure 2). During the same period, the use of berries (mostly *Vaccinium* sp., *Amelanchier* sp., and *Aralia nudicaulis*) increased (2% to 56% of volume) whereas the use of small mammals (17% to 14% of volume) and vegetation (11% to 13%) remained stable (Figure 2). In 1991, the feeding habits of Coyotes shifted from predominantly Moose (*Alces alces*) (28%-33% of volume) and Snowshoe Hare (*Lepus americanus*) (49%-32% of volume) in May-June, to predominantly berries in July-October (41%-80% of volume) (Figure 2). The use of small mammals remained more constant, fluctuating from 8% to 23% between May and October (Figure 2).

Food habits differed significantly between 1988 and 1991. In June 1988, White-tailed Deer, Woodchuck and vegetation (grasses and sedges) comprised up to 61% of the volume of scats, but they were mostly replaced by Moose, Snowshoe Hares and Beavers (*Castor canadensis*) in 1991 (total volume = 73%; Table 1). In July, the trend remained the same for the Deer and Woodchuck, whereas berries increased markedly from 1988 to 1991 (Table 1). Woodchuck consumption was higher in August 1988 compared to 1991, while the intake

of berries was lower (Table 1). During the three month period, the use of vegetation was higher in 1988 than in 1991.

Discussion

Population density

Precision of our population density estimates (± 35 -36%) was limited by the small number of Coyotes marked. Also, the size of this population may have been overestimated as two of the seven radiocollared Coyotes may have left the capture area. The assumption of a closed population, required for the Petersen index, is therefore violated, causing an underestimation of the recapture/capture ratio. Nevertheless we believe that this estimate is representative of the low carrying capacity of eastern boreal forests. Indeed, our estimates of density were among the lowest ever recorded for a Coyote population. Comparisons of population density between studies are often difficult due to differences in techniques of estimation. However, the summer density of Coyotes seems much clearly higher in southern United States and western Canada, varying from 3 to 20 Coyotes/10 km² (Bowen 1982; Pyrah 1984; Andelt 1985; Hein and Andelt 1995). In northeastern North America reported densities also vary: 1 Coyote/10 km² in Ontario (Voigt and Berg 1987), 1.2 Coyotes/10 km² in southern Québec (Messier et al. 1986) and 2 Coyotes/10 km² in Minnesota (Berg and Kuehn 1986). Fortin (1995) estimated a minimum density of 0.7 Coyote/10 km² in the mixed

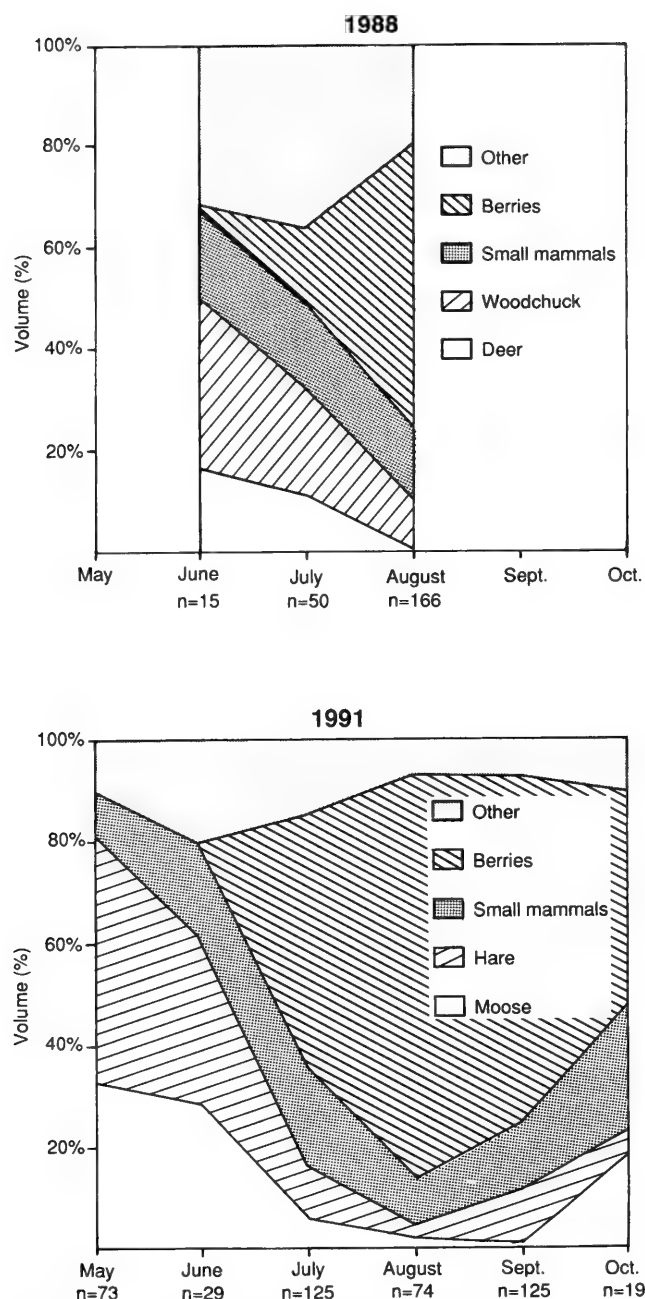


FIGURE 2. Average volume (%) of food items in Coyote scats during summers of 1988 and 1991 in the centre of the Gaspé peninsula (Québec). Sample size was 231 scats in 1988 and 435 in 1991.

forests of Forillon National Park, 110 km east of our study area. Fewer density estimates are available for boreal forests. In Alberta, winter density averaged 3 Coyotes/10 km² (Todd et al. 1981). Density, however, fluctuated from 1.4-2.5 Coyotes/10 km², when Snowshoe Hares were scarce, to 4.4 Coyotes/10 km², when Hares became abundant. As the number of Coyotes in our study area was most likely near their peak following colonization of the Gaspé Peninsula, our low density estimate suggests a consequent low carrying capacity of their environment, especially since the White-tailed Deer had declined (Poulle et al. 1993).

Food habits

Differences in the diet between 1988 and 1991 may have been caused by a change in the availability of certain prey types. If so, the decrease in the consumption of deer and Woodchuck in 1991 could be related to a decline in the abundance of these prey types. Indeed, harvest of deer on the Gaspé peninsula, which may be used as an index of population trends, decreased from 620 individuals in 1988 to 143 in 1991. The consumption of Moose, Snowshoe Hares and Beavers was greater in 1991 than 1988, possibly due to a greater abundance of these species. However, while Moose harvest increased from 1988 ($n=590$) to 1991 ($n=679$) (Bouchard 1990*; Lamontagne et al. 1992*), the number of harvested Hares declined (1988: 63.3 Snowshoe Hare/100 km²; 1991: 24.2 Hare/100 km²) (R. Lafond, Ministère de l'Environnement et de la Faune, unpublished data). In the CCGR, the harvest of Beavers declined from 67 during the winter of 1987-1988, to only 11 during winter 1990-1991 (R. Lafond, Ministère de l'Environnement et de la Faune, unpublished data). We hypothesize that the number of Woodchucks and Deer may have been so depressed in 1991 that Coyotes were forced to switch to Moose, Beavers and Snowshoe Hares, even though the two latter species were less abundant in 1991 than in 1988.

The decline of deer on the Gaspé peninsula was due, in part, to Coyote predation (Crête and Lemieux 1994*; Poulle et al. 1993). However, there is no evidence in the literature that Coyotes may significantly reduce Woodchuck numbers. Adult Woodchucks may weight 5 kg (Lee and Funderbury 1982) and represent a profitable and reliable prey for eastern Coyote. Open woodlands and clearings are its prime habitat (Lee and Funderburg 1982), but Woodchucks are confined to recent clearcuts and roadsides in boreal forests. Although populations of this species are generally resilient (Davis 1962; Davis et al. 1964), the restricted distribution of this rodent may have contributed to a decline in Woodchuck numbers when Coyotes arrived in the area. Woodchucks also were important in the summer diet of Coyotes when they colonized New Brunswick (Parker 1986). Unfortunately, no data on Woodchuck abundance in our study area were available to test this hypothesis further.

The importance of Coyote predation to the declines of Snowshoe Hare and Beaver in the study area remains uncertain. Snowshoe Hare populations do experience periodic fluctuation and predation has been implicated in these demographic changes (Keith et al. 1981; Keith 1990).

Monthly differences in the food habits of Coyotes generally reflect changes in the food availability (Van Vuren and Thompson 1982; Andelt et al. 1987; MacCracken and Hansen 1987; Cypher et al. 1993).

TABLE 1. Comparison of the summer diet of Coyotes in boreal forests of the Gaspé peninsula (Québec) when the population was expanding (1988), and declining following colonization (1991). Diet was estimated as percent volume (%) of food items in scats. Monthly comparisons were tested with the Mann-Whitney U test; *n* = the number of scats examined.

	June		July		August	
	1988 (<i>n</i> =15)	1991 (<i>n</i> =29)	1988 (<i>n</i> =50)	1991 (<i>n</i> =125)	1988 (<i>n</i> =166)	1991 (<i>n</i> =74)
Moose	0.0**	28.0**	6.3	5.9	1.5	1.9
Deer	16.3*	1.8*	11.2**	0.0**	0.5	0.0
Snowshoe Hare	13.3	32.3	9.9	10.5	2.4	2.5
Woodchuck	33.7**	5.0**	21.0*	0.5*	9.6*	0.4*
Beaver	0.0*	12.7*	0.0	0.0	0.0	0.0
Small mammals	17.0	18.0	16.8	19.1	14.2	9.1
Other mammals	0.0	0.0	5.7	5.7	0.0	1.2
Birds	6.7	2.1	1.6	2.4	3.2	2.4
Berries	1.7	0.0	14.6**	49.5**	55.7**	79.5**
Vegetation	11.3**	0.0**	12.8*	6.4*	12.8**	2.9**

P* < 0.10, *P* < 0.05.

Moose and Deer were probably consumed as carrion in May-June, as all hairs found in the scats were from adults. Remains of large mammals that died during winter are available to, and often used by, Coyotes in spring (Hawthorne 1972; Parker 1986; Reichel 1991). Parker (1986) hypothesized that Coyotes have less difficulty catching Woodchucks in May-June compared to other seasons because Woodchucks are particularly vulnerable when foraging for new vegetation growth; our results for 1988 support this view. The same may also apply to Snowshoe Hares. Indeed, Snowshoe Hares may be more easily found by predators in May because their white winter coat is not fully replaced and the snow has almost completely melted (Bittner and Rongstad 1982). Also, young Woodchucks begin to emerge

from their natal dens in early summer when young hares become available (Lee and Funderburg 1982; Bittner and Rongstad 1982), and their inexperience leaves them vulnerable to predation.

In our study area, berries were most available from late July to early October, a time when Coyotes made a large use of that food source. In fact, the use of berries by Coyotes was more pronounced in our study area than in other regions of North America (Table 2). Although study periods differed in the comparisons, each always included at least the peak of berry ripening in July-August. In our study, the volume of berries in scats averaged 24% during June to August 1988, and 40% during May to October 1991. In comparison, berries represented less than 1% of the volume in most other studies (Table 2),

TABLE 2. Food habits (% volume) of Coyotes during summer in various regions of North America.

Area	Habitat type	Items		Period	Source
		Animal	Berries		
Québec	Boreal forests	64	24	June-August 1988	Present study
		58	40	May-October 1991	
Québec	Mixed northern hardwood-coniferous forests ^a	95	<1	May-October	Fortin (1995)
Québec	Mixed northern hardwood-coniferous forests ^a	78	14	July-August	Messier et al. (1986)
Alberta	Boreal forests ^a	84	1	June-September	Todd et al. (1981)
California	Chapparal	80	- ^b	July-September	Hawthorne (1972)
California ^c	Chapparal-grassland	99	1	Summer ^d	Ferrel et al. (1953)
Idaho	Grassland	93	1	July-October	Johnson and Hansen (1979)
Idaho	Grassland	71	- ^b	July-August	MacCraken and Hansen (1987)
Oklahoma	Grassland-woodland	65	- ^b	July-August	Holle (1978)
Central and Western U.S.A. ^c	Mostly grassland	97	4	July-August	Young and Jackson (1951)

^awith farmlands

^bnot specified but apparently not used.

^cstomach contents.

^dNo precise date specified.

except in southern Québec where volume averaged 14% in July-August (Messier et al. 1986). Other studies also concluded that berries were an important part of the Coyote diet during summer (Barett 1983; Harrisson and Harrisson 1984; Parker 1986; Andelt et al. 1987; Litvaitis and Harrisson 1989; Dibello et al. 1990; Riechel 1991; McClure et al. 1995). However, those studies used the frequency of occurrence rather than volume to describe Coyote food habits. The use of small food items, such as berries, are often overestimated by frequency of occurrence (Weaver and Hoffman 1979).

The high use of berries, especially in 1991, may have results from a high availability of this food source. Many scats were collected along logging roads in clear-cuts where berries were common. However, as White-tailed Deer, Snowshoe Hare and possibly Woodchuck and Beavers were less abundant in 1991, it is also possible that Coyotes consumed more berries to compensate for the low number of animal prey. Indeed, some authors suggest that rodents and lagomorphs are preferred by Coyotes and that other items are used only when those prey are not available (Todd et al. 1981; Barrett 1983; Cypher et al. 1993; Hernandez and Delibes 1994).

If food habits and low population density were due to a scarcity of animal prey in our study area, then the low abundance of prey may also explain why the fecundity of female Coyotes is exceptionally low on the Gaspé peninsula (Pouille et al. 1995). In Alberta, fecundity of Coyotes was correlated with abundance of hares (Todd et al. 1981). The fecundity of females Red Fox (*Vulpes vulpes*), also appeared to be influenced largely by the availability of prey (Lindström 1988). If such is true for Coyotes, it might suggest that a high consumption of berries, containing mostly carbohydrates, may not compensate for required lipids and proteins that Coyotes obtain from animal prey, thus influencing reproduction. This hypothesis is based on the assumption that foraging activities in summer and early fall influence female reproduction during the next spring.

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Egg Composition and Post-DDT Eggshell Thickness of the American White Pelican, *Pelecanus erythrorhynchos*

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Bugden, Shawn C., and Roger M. Evans. 1997. Egg composition and post-DDT eggshell thickness of the American White Pelican, *Pelecanus erythrorhynchos*. Canadian Field-Naturalist 111(2): 234–237.

Eggs of the American White Pelican (*Pelecanus erythrorhynchos*) were collected from a breeding colony at East Shoal Lake, Manitoba. Egg contents were 17.5 ± 0.4 percent yolk, had an energetic density of 4.77 ± 0.06 kJ/g and contained 82.8 ± 0.2 percent water. These results suggest a typically altricial composition for the eggs of the American White Pelican and strengthen the evidence that this is true of the family Pelecanidae in general. After thinning significantly in the prairie region during the late 1960s, eggshell thickness of the American White Pelican in Manitoba has recovered. Eggshell thickness (0.685 ± 0.018 mm) and eggshell mass (16.54 ± 0.55 g) were not significantly different from pre-DDT (prior to 1947) measurements reported in the literature (0.683 mm and 16.56 g).

Key Words: American White Pelican, *Pelecanus erythrorhynchos*, egg composition, eggshell thickness, DDT.

The relative yolk content and energetic density of eggs correlate well with the position of a species on the altricial to precocial continuum of developmental maturity at hatch (Nice 1962; Carey et al. 1980). Pelagic-feeding Procellariiformes, offshore-feeding terns with their long incubation periods (Carey et al. 1980; Sotherland and Rahn 1987), and some Columbidae may represent significant exceptions to the general trends (Ricklefs 1977; Carey et al. 1980). Two members of the altricial family Pelecanidae have been studied. The Great White Pelican (*Pelecanus onocrotalus*) produces eggs that are typical of most altricial species (Jones 1979; Williams et al. 1982). Eggs of the Brown Pelican (*Pelecanus occidentalis*) (Lawrence and Schreiber 1974) were found to deviate from the typical composition of an altricial egg with energetic densities similar to semi-precocial species (Ricklefs 1977; Carey et al. 1980). However, some of the Brown Pelican eggs studied (3 of 6) had been incubated for up to three weeks (Lawrence and Schreiber 1974), which may have significantly influenced the results (Ricklefs 1977; Jones 1979). To assess further egg composition in the family Pelecanidae, we examined a third species, the American White Pelican (*Pelecanus erythrorhynchos*).

Prior to the widespread use of DDT (pre-1947), eggshells of American White Pelicans collected in the interior of North America had an average thickness of 0.683 mm with 95% confidence limits of 0.673 - 0.693 mm and an average dry eggshell mass of 16.56 g (Anderson and Hickey 1972). By 1952, eggs collected in Manitoba showed some evidence of thinning with an average thickness of 0.654 mm with 95% confidence limits of 0.628 - 0.680 (Anderson and Hickey 1972). Eggs collected in the prairie states and provinces in 1965 were significantly thinner than pre-DDT eggshells with an average

thickness of 0.655 mm with 95% confidence limits of 0.643 - 0.667 mm (Anderson et al. 1969). Another sample of pelican eggs from the interior of North America collected in 1965 to 1968 showed a significant 5% decline in eggshell thickness with an average of 0.647 mm and 95% confidence intervals of 0.621 - 0.673 mm (Anderson and Hickey 1972). The dry eggshell mass of these eggs also showed a decline, with a 9% drop from pre-DDT measurements (Anderson and Hickey 1972).

Eggshell thinning was even more pronounced in eggs collected from other areas of North America (Anderson and Hickey 1972). Eggs collected in the late 1960s in California and British Columbia showed declines of 8 and 13 percent from pre-1947 measurements. In 1972 an average eggshell thickness of $0.620 + 0.0063$ mm was found in eggs collected from Gunnison Island, Great Salt Lake, Utah (Knopf and Street 1974). Eggshells in 1965 and 1972 were significantly thinner than the pre-1940 samples and inversely related to the level of the DDT metabolite DDE found in pelicans (Anderson et al. 1969; Knopf and Street 1974). The widespread usage of DDT from 1943 to 1971 and resulting bioaccumulation in fish-eating birds like pelicans is believed to have contributed to eggshell thinning (Hickey and Anderson 1968; Anderson et al. 1969). The only reported post-DDT (post-1971) measurements of eggshell thickness in the American White Pelican were from eggs collected in the Klamath region in California (Boellstorff et al. 1985; Evans and Knopf 1993). These eggs showed an increase in shell thickness from 1969 (15% below pre-1947 thickness) but were still 10% below pre-1947 values in 1977 and 1981 (Boellstorff et al. 1985). We obtained current eggshell measurements for comparison with measurements taken prior to and during the widespread usage of DDT.

Methods

Ten freshly laid eggs were collected in the spring of 1994 from an American White Pelican breeding colony at East Shoal Lake, Manitoba. Eggs were removed from a single subcolony (Knopf 1979) to minimize disturbance to the rest of the colony (Boellstorff et al. 1988; Evans and Knopf 1993). Prior observations from a protected tunnel blind made it possible to identify and take eggs of known chronology during a brief (10-min) visit to a single edge subcolony, thereby reducing the amount of disturbance. Egg length and breadth were measured with vernier calipers to the nearest 0.1 mm. Egg volume was calculated using the formula, $V = KLB^2$ where L is the egg length, B is the egg breadth and K is the species constant of 0.500 (O'Malley and Evans 1980). Egg volume can also be estimated by the difference between the mass of the egg in air (W_1) and its mass when submerged in water (W_2). The density of water was assumed to be 1.00 g/cm³. Initial weights of the whole egg were made in both air and water to the nearest 0.1 g. Specific gravity was calculated from the formula, $(W_1 / (W_1 - W_2))$ (Evans 1969). The eggs were then boiled for 10 minutes, allowed to cool to room temperature, placed in air tight containers and then frozen for later analysis.

Eggs were thawed, separated into components, and weighed to the nearest 0.01 g using a Mettler balance. Any loss in mass from the boiling and freezing process was attributed to albumen water loss and corrected by adding the difference between the fresh whole egg and the thawed egg to the wet albumen mass (Williams et al. 1982; Meathrel et al. 1987). The components were dried for 72 hours at 60°C and then weighed for dry mass. Shell thickness, including membranes, was measured (+0.001 mm) using a modified Starrett Model 1010M micrometer. Mean shell-thickness was obtained by averaging eight lateral readings, taken at the egg's equator, midway between the caps (Knopf and Street 1974).

Dried yolk and albumen were ground to a uniform powder. Samples of the albumen and the yolk of each egg were burned in a bomb calorimeter (Parr 1241 Calorimeter, Parr Instrument Co., Moline, Ill.) to determine their energy content. Two samples each

of yolk and albumen were tested and the average result was taken. Additional aliquots of yolk and albumen were used to determine the lipid content. Lipid content was determined by Soxhlet extraction using petroleum ether (Arnold 1992) for eight hours for yolk samples and four hours for albumen samples. Samples were run in duplicate with the average result taken. The energetic content of the egg was then calculated indirectly assuming 40 kJ/g for lipids and 23.5 kJ/g for the non-lipid fraction of the egg contents (Sotherland and Rahn 1987). All means are presented \pm 1 SE.

Results

Fresh pelican eggs had a mass of 156.2 ± 3.8 g and had a length of 87.8 ± 1.1 mm and breadth of 56.9 ± 0.7 mm. Calculation of egg volume based on length and breadth gave a value of 142.4 ± 3.6 cm³ which was not significantly different from egg volume based on $(W_1 - W_2)$ of 140.5 ± 3.2 cm³ (paired $t = 1.84$, $P > 0.05$, $df = 9$). Specific gravity was 1.110 ± 0.005 . The wet and dry mass of egg components are shown in Table 1. The fraction of the yolk in the contents was 0.175 ± 0.004 . Egg shell thickness was 0.685 ± 0.018 mm.

The yolk made up 17.5 ± 0.4 percent of the egg contents. Dry yolks contained $61.7 \pm 0.5\%$ lipid and were shown by bomb calorimetry to contain 32.9 ± 0.1 kJ/g (dry mass). Dry albumen contained $0.3 \pm 0.06\%$ lipid and had an energetic content of 21.4 ± 0.04 kJ/g (dry mass). The overall energy of the dry egg contents was 27.7 ± 0.1 kJ/g. The energy of the wet contents was compared with other members of the family Pelecanidae (Table 2). The energy of the wet contents was also estimated based on the percentage of lipid in the contents (5.1 ± 0.1) and literature values for the energy of lipid and non-lipid fractions of egg contents (Sotherland and Rahn 1987). This value, 4.73 ± 0.06 kJ/g was very similar to the energetic value based on bomb calorimetry (Table 2).

Discussion

Eggs did not differ significantly in size (length, breadth and mass) from fresh eggs measured in previous studies in Manitoba ($P > 0.50$) (Evans 1969;

TABLE 1. Mass of fresh American White Pelican egg components.

Component	Wet Mass (g)		Water ¹	Dry Mass (g)	
	Mean \pm SE	%		Mean \pm SE	%
Albumen	114.14 \pm 3.16	73.1	89.2	12.38 \pm 0.45	30.7
Yolk	24.09 \pm 0.46	15.4	52.6	11.41 \pm 0.69	28.3
Contents	138.23 \pm 3.41	88.5	82.8	23.79 \pm 0.58	59.0
Shell	17.92 \pm 0.62	11.5	7.6	16.54 \pm 0.55	41.0
Total egg	156.2 \pm 3.7	100	74.2	40.33 \pm 0.91	100

¹Water as a percentage of wet mass of the component; other percentages are in relation to total egg mass.

TABLE 2. Energy and composition of egg contents in the family Pelecanidae.

Species	Yolk/Albumen			
	kJ/g	Ratio	N	Ref.
<i>Pelecanus erythrorhynchos</i>	4.77*	0.21	10	1
<i>Pelecanus occidentalis</i>	6.22	0.40	6	2
<i>Pelecanus onocrotalus</i>	5.16	0.26	54	3
<i>Pelecanus onocrotalus</i>	4.49	0.17	1	4

References: 1. This study; 2. Lawrence and Schrieber (1974);
3. Jones (1979); 4. Williams et al. (1982).

*Energy value was based on bomb calorimetry.

O'Malley and Evans 1980). As eggs lose water at a relatively constant rate during incubation, the specific gravity of eggs can be used to estimate the time elapsed since laying (Westerkov 1950). Specific gravity was not significantly different than that of 21 freshly laid eggs in a previous study ($t = 0.65$, $P > 0.50$, $df = 29$) (O'Malley and Evans 1980).

The water content of the fresh bird egg typically correlates with the state of hatching maturity of the chick (Sotherland and Rahn 1987). The fraction of water in the contents of altricial American White Pelican eggs (Table 1) is similar to the altricial species average of 84.3% (Carey et al. 1980). The fraction of water in the albumen (Table 1) is relatively uniform (85-90%) among all species of birds (Ricklefs 1977; Sotherland and Rahn 1987). The water content of American White Pelican egg yolk (Table 1) fell within, but near the low end of, the altricial range (52.4% to 65.5%) (Sotherland and Rahn 1987).

Calculations of energetic density based on bomb calorimetry and lipid extraction produced very similar results. The similarity of the results supports the use of either bomb calorimetry or lipid extraction for estimation of the energy content of eggs. The energy of the dry contents of eggs is relatively uniform in all species of birds (Carey et al. 1980; Ar et al. 1987). Our results put the American White Pelican (27.7 kJ/g) within one standard deviation of Sotherland and Rahn's (1987) average energy density of $29.1 \pm 1.5(\text{SD})$ for 99 species of birds.

The energy of the wet contents of avian eggs typically correlates with the hatchling's maturity (Ar et al. 1987; Sotherland and Rahn 1987). The energetic density of the contents of the eggs of the American White Pelican and the Great White Pelican (Table 2) fall within the 95% confidence interval (4.771 - 5.193) of the average (4.982 kJ/g) reported for other altricial species (Ar et al. 1987). The energetic density previously reported for Brown Pelican eggs (Table 2) falls well outside of the normal range for altricial species. The high energetic density and the low fraction of water in egg contents (76.7%) reported for the Brown Pelican probably reflects the effects of embryonic development and water loss associated with eggs

that had been incubated for up to three weeks (Lawrence and Schreiber 1974; Jones 1979; Williams et al. 1982). Analyses of eggs of the Great White Pelican (Jones 1979; Williams et al. 1982) and the American White Pelican (this study) support the conclusion that birds of the family Pelecanidae produce eggs typical of altricial birds.

Eggshell thickness significantly increased from measurements taken in 1972 (Utah), at the end of almost 30 years of DDT usage ($t = 3.16$, $P < 0.01$, $df = 108$) (Knopf and Street 1974). Our eggshell thickness measurements were also significantly greater ($t = 3.54$, $P < 0.001$, $df = 79$) than measurements taken in 1981 (California; Boellstorff et al. 1985). Western populations were more affected by DDT than interior populations (Anderson and Hickey 1972). Although prairie populations experienced a smaller decline (5% in late 1960s; Anderson and Hickey 1972), our results indicate that eggshell thickness in this population returned to pre-DDT levels. Present day post-DDT eggshell thickness ($t = 0.12$, $P > 0.50$, $df = 100$) and eggshell mass ($t = 0.04$, $P > 0.50$, $df = 102$) were not significantly different from measurements taken from prairie populations in the pre-DDT period prior to 1947 (Anderson and Hickey 1972). Although a direct link between eggshell thinning and reproductive success in American White Pelicans has not been established (Anderson et al. 1969; McEwen and Stephenson 1979) it is comforting to report that with the recovery of eggshell thickness in the sampled population this potential problem has been avoided.

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Population Growth of Moose, *Alces alces*, in Labrador

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Moose (*Alces alces*), although not historically resident in Labrador, have increased in numbers and range over the past four decades. Densities of Moose remain comparatively low (0.013 - 0.168 animals/km²), but several indicators reveal an expanding population. Successive surveys of two Moose management areas in south-central Labrador, conducted in 1986 and again in 1994, indicated an average finite rate of increase of 1.10. Similarly, calf:cow ratios are relatively high, ranging from 0.30 to 0.67. Twinning rates were estimated at less than 11% of the total calf crop. During late winter animals appeared to be non-gregarious with mean group size of 1.4. Moose hunting in Labrador commenced in 1977; hunter success, as indicated by annual license returns, increased substantially during the period 1977–1993. Incidental observations have indicated northward range expansion of Moose to the treeline in Labrador.

Key Words: Moose, *Alces alces*, population growth, density, winter range, Labrador.

In Labrador, the first Moose sightings occurred during the early 1950's (Harper 1961) in the south-west near Ashuanipi Lake and are independent of the introduction attempts in southeastern Labrador near St. Lewis River in 1953 (Figure 1). By 1953, Moose were already present in southwestern Labrador (Mercer and Kitchen 1968). Range expansion into Labrador appears to have occurred through natural dispersion from Québec in a northeasterly direction along river valleys (Mercer and Kitchen 1968). By 1977, Moose had populated south-central Labrador in numbers sufficient to warrant the establishment of 13 management areas and an annual sport hunt. More recently, in western Labrador, an additional management area has been established. Very low Moose densities and large management areas precluded reliable systematic counts prior to 1986.

Although anecdotal observations of Moose in Labrador are strongly suggestive of a growing population, there has been little formal analysis of the extent and magnitude of this trend. Here we use a combination of sources to document demographic changes in Moose. First, we compared successive surveys in two Moose Management Areas (MMAs), conducted in 1986 and repeated in 1994. For regional comparisons, we summarized density estimates of four other MMA's. Second, we used hunter statistics as an indirect index on population structure and trends (Fryxell et al. 1988). The harvest of Moose in Labrador has been well documented through licence returns and telephone inquiries since the initial open season in 1977. Finally, we collated information on Moose sightings to determine the current northern limit of the species in the region.

Study Area

Successive aerial surveys were conducted in two MMAs within the High Boreal Forest-Lake Melville ecoregion (Lopoukhine et al. 1977; Meades 1990*), consisting of taiga, subalpine tundra, and the transitional vegetation types. Stands of Black Spruce (*Picea mariana*) and Balsam Fir (*Abies balsamea*) occur on shallow upland soils whereas open spruce lichen forest can be found on upland till and outwash soils. White Birch (*Betula papyrifera*) and Trembling Aspen (*Populus tremuloides*) occur on well-drained alluvium soil. Mosses of the genus *Sphagnum* dominate bogs. Common associates included Labrador Tea (*Ledum groenlandicum*), Sheep Laurel (*Kalmia angustifolia*), Bunchberry (*Cornus canadensis*), Partridgeberry (*Vaccinium vitis-idea*) and Low Sweet Blueberry (*Vaccinium angustifolium*). Forest harvesting has continued in the Muskrat Falls area since the 1950s, increasing human access and expanding areas of successional browse species preferred by Moose including Alder (*Alnus rugosa*), White Birch, Willow (*Salix* sp) and Balsam Poplar (*Populus balsamea*). Approximately 27% of the Muskrat Falls area (Area 53; Figure 1) is composed of deciduous species in various stages of regeneration. The Grand Lake area (Area 54; Figure 1) has some commercial forestry harvest and significant burned areas resulting in nearly 7% deciduous regeneration.

This region has long, severe winters with heavy snow accumulation and short summers. Snow nor-

*See Documents Cited between Acknowledgements and Literature Cited.

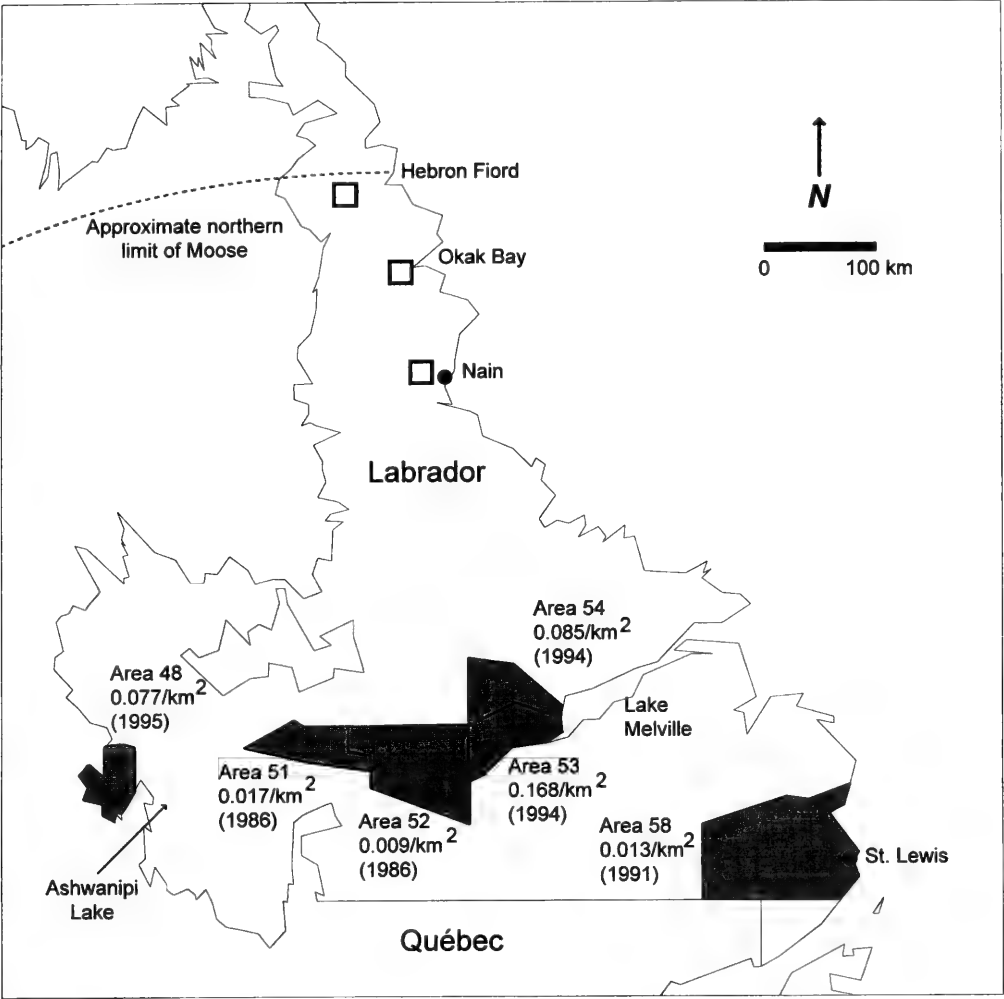


FIGURE 1. Moose Management Areas in central Labrador indicating densities and year of most recent survey. Extreme northern sightings of Moose or their sign are indicated by open squares.

mally begins in October and may persist into June. Mean daily temperatures range from -14 to -18°C in February and 13°C in July. Average annual precipitation is 1100 mm with an average snowfall accumulation of 4 m.

Besides man, potential predators of Moose in the study area include Wolves (*Canis lupus*), Black Bears (*Ursus americanus*), and possibly Lynx (*Lynx canadensis*).

Methods

During 1994 and 1995, population estimates were conducted using stratified random sampling (Gasaway et al. 1986). To estimate population growth, we compared Moose densities in two MMAs surveyed in 1986 and again in 1994 (Areas 53 and 54, Figure 1). We delineated all possible subunits on 1:50 000 scale topographic maps of the management areas. Subunits (4 km²) were defined by Universal Transverse Mercator grid lines on topographic maps. The survey area was then stratified into “high” and “low” density strata using Forestry Inventory Maps

and incidental Moose observations during preliminary flights to determine preferred habitat. Flights were conducted using a Bell 206L helicopter at altitudes ranging from 30 to 50 m agl at 50 to 100 km/h. Calf:cow ratios and population sex and age structure were obtained during aerial counts. Sex was determined by the presence or absence of a vulva patch (Mitchell 1970), antlers or a calf.

During 8 to 12 March 1994, we conducted a stratified random block survey to estimate Moose population parameters in MMA’s 53 (Muskrat Falls) and 54 (Grand Lake). We estimated Moose populations and quantified the rate of increase since the last census. Both MMA’s share an adjoining boundary which has changed slightly since 1986 but both encompass the same area censused in 1986. To enable between survey comparisons, we examined changes in Moose density and sex and age structure.

Areas of high Moose density generally included riverine habitat, regenerated clear cuts and deciduous forest. The low density stratum comprised areas of high elevation, closed canopy mature Black Spruce

TABLE 1. Moose Sex and Age Composition within two Moose Management Areas (MMA's) in Labrador during 11–12 March, 1994.

MMA	n	Adult sex ratio bulls:cows	Percent of population			
			bulls	cows	calves	unknown
Grand Lake	52	47:53	35	38	12	15
Muskrat Falls	79	40:60	25	38	25	1

forests, recent burns and barrens. Both strata were assigned identification codes and individually numbered subunits were randomly selected for sampling. A sightability correction factor (SCF) was calculated using five high density subunits in the Grand Lake MMA. We performed a standard search effort (2–4 min/km²) to locate Moose followed by an intensive search (5 to 8 min/km²) the following day. We determined a SCF of 1.6 for high density strata. This is slightly lower than correction factor of 2.3 used on the west coast of Newfoundland (Albright and Keith 1987) where Moose densities were relatively high and cover dense. We believe that all Moose were located in low density strata due to the openness of the terrain and thus no correction factor was applied. Since both management areas were similar in strata composition, we used the same sightability correction factor and sampling variance for both areas.

The Grand Lake MMA has a total area of 3797 km², of which 3732 km² was considered possible Moose habitat. We delineated 264 km² (7%) as high density stratum and 3468 km² (93%) as low density stratum. Our survey encompassed 26 (39%) of 66 subunits of the high density stratum and 39 (4%) of 975 low density subunits. The Muskrat Falls MMA has a total area of 4021 km² of which 3872 km² was considered possible Moose habitat. We delineated 800 km² (21%) as high density stratum and 3072 km² (79%) as low density stratum. We surveyed 43 (22%) of 200 subunits of the high density stratum and 15 (2%) of 768 subunits in the low density stratum.

Excellent weather conditions prevailed throughout the entire survey period. Heavy snowfall in late February until 7 March effectively covered old tracks, enabling an efficient search effort. Days were sunny and bright with temperatures ranging from -2° to -15°C and winds were generally northwesterly ranging from 0 to 15 km/hr. With constant weather conditions, movement of Moose between strata appeared minimal during the survey.

Hunter success rate was determined annually using licence and mandible returns complemented by intensive telephone inquiries. Outcomes of all licences were accounted for each year. As an additional indication of population growth we used regression analysis to correlate hunter success with time during 1977–1993.

In addition, we summarized Moose densities from the results of occasional aerial surveys conducted between 1991 to 1995 (Newfoundland and Labrador Wildlife Division, unpublished data) in six MMAs (Figure 1). Prior to 1994, MMAs were surveyed using stratified line transect surveys.

Results and Discussion

Distribution

Historically, Moose have been distributed more southerly along the Labrador Ungava Peninsula. Northern limits in Québec appeared to be along 53°E latitude in the early 1950s (Brassard et al. 1974) which corresponds to the northernmost observations of Moose in the Lake Melville region of Labrador (Mercer and Kitchen 1968). Range expansion in Québec reached the 57° in the late 1970s (Brassard et al. 1974). Recent observations in Labrador confirm a similar northward range extension north of 58° (Figure 1).

By 1980, Moose had been observed as far north as Nain (F. Phillips, personal communication). Most recently, independent sightings of two Moose during fall 1995 (1 adult male; 1 unknown sex) have been made as far north as Ikinet River (57°24'; 62°32'), west of Okak Bay (J. Ennis, personal communication). Evidence of browsing on willows (*Salix* spp.) and fecal droppings were observed in October 1995, south of the Ikarut River (58°04'; 63°22') northwest of Hebron Fiord (G. Baikie, personal communication).

This indicates a rate of spread of 8 km/yr since 1980, slightly lower than the 10 km/yr spread rate initially reported for Moose in Labrador (Mercer and Kitchen 1968). Similarly, Pimlott (1953) reported that Moose introduced into Newfoundland spread at a rate of 11 km/yr. Nevertheless, because the current extension has now reached the treeline, it appears that Moose may have reached their northern most geographic distribution in Labrador. Although Moose occur in treeless, shrub-dominated, alpine habitat in Alaska (Gasaway et al. 1986), the expansion of Moose into the subarctic tundra of Labrador is unlikely (Ballard et al. 1991; Doerr 1983).

Our observations revealed that Moose in the region tended not to aggregate during winter (1.4 Moose/group) compared to other ranges where groups ranged from 1.8 to 2.3 Moose/group (Rolley and Keith 1980; Mytton and Keith 1981). Similarly, Dalton (1986) recorded a mean group size of 1.3.

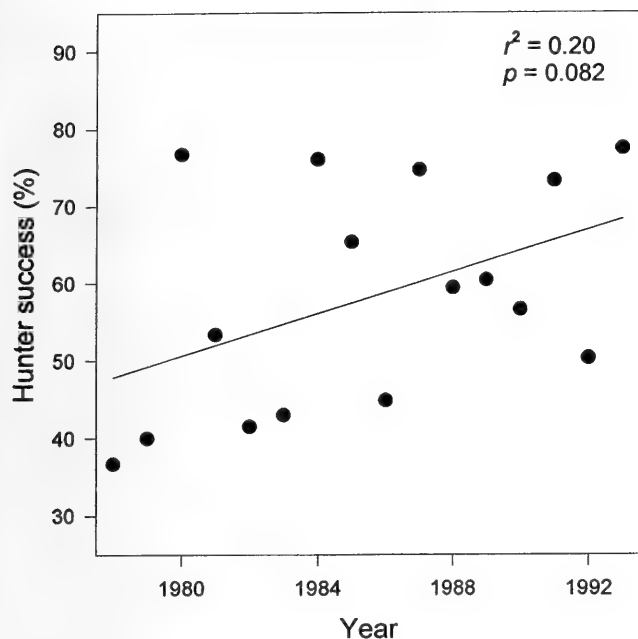


FIGURE 2. Hunter success for Moose in Labrador, 1977-1993.

Yarding was nonexistent (largest group was four animals), even though the population had increased significantly, probably due to the low densities of Moose and lack of winter browsing areas.

Population Growth

During 1994, in the Grand Lake MMA, we counted 46 and 6 Moose in the high and low density strata respectively. Our estimate indicated a Moose population of 321 ± 218 (90% CI) or 0.085 Moose/km². Dalton (1986) estimated the population at 245 or 0.043 Moose/km² (no CI provided). This indicates an increasing population, growing at a rate of $\lambda = 1.09$ over 8 years. In the Muskrat Falls MMA, we counted a total of 77 and 2 Moose in the high and low density strata respectively. We estimated a Moose population of 677 ± 359 (90% CI) or 0.168 Moose/km². Dalton (1986) estimated the population at 398 or 0.074 Moose/km² (no CI provided). This population had increased over 8 years with $\lambda = 1.11$.

Moose densities in southern Labrador appear low (0.013 - 0.168/km²) but comparable to analogous ranges elsewhere in the north. Similar habitats in north-central Québec produce 0.06 to 0.11 Moose/km² with densities exceeding 1.8 Moose/km² in the most productive southern regions (Brassard et al. 1974). Stenhouse et al. (1995) reported densities of 0.155 Moose/km² in the Northwest Territories. There is some evidence that the scope for further increases in the Moose population are limited in Labrador, possibly due to illegal harvests, wolf predation (Trimper et al. 1996), marginal habitat, or some combination.

Population Structure

In the Grand Lake area, adult bull:cow ratio was

47:53, whereas in Muskrat Falls, where only male licenses have been issued, the ratio was slightly more in favour of females at 40:60 (Table 1). Dalton's (1986) bull:cow ratios of 43:57 and 42:58 for Muskrat Falls and Grand Lake respectively were similar to those obtained in 1994. Dalton (1986) estimated calves comprised 22% and 12% of the total population in Grand Lake and Muskrat Falls respectively. In 1994, calves comprised 12% and 25% of the total population for Grand Lake and Muskrat Falls respectively (Table 1). During the 1994 census no evidence of twinning was observed in the Grand Lake area while Muskrat Falls area had a low twinning rate of 11%. These rates are much lower than observed in the Northwest Territories (31%) where Moose densities are similar (Stenhouse et al. 1995). Our productivity is also much lower than that of Moose populations across North America where twinning rates average 33% (Boer 1992). Calf:cow ratios were 0.48 and 0.24 in 1986 compared to 0.30 and 0.67 in 1994, for Grand Lake and Muskrat Falls areas respectively. These results further imply that continued growth of Labrador Moose populations is likely limited.

Hunter Returns

Abundance estimates such as kills per day and Moose seen per day have been shown to be valid indices of Moose abundance provided that changes in hunting pressure are also accounted for (Fryxell et al. 1988). We used annual hunter success (kills per licence) from 1977 to 1993 as an indicator of Moose abundance. Hunter success rates ranged from a low of 37% in 1977 to a high of 77% in 1993 (Figure 2). Regression analysis indicated a moderate increase in annual hunter success ($r = 0.20$, $p = 0.082$). Although licence quotas have increased slightly, the increased success rate indicates that the Moose population has increased.

Acknowledgments

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Resurgence of Breeding Merlins, *Falco columbarius richardsonii*, in Saskatchewan Grasslands

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The Richardson's Merlin (*Falco columbarius richardsonii*) almost disappeared from Saskatchewan grasslands in the early 1960s, coincident with extensive use of dieldrin for grasshopper control in adjacent grainfields. Merlins reappeared in small numbers in 1975 and 1976 and gradually increased. Unlike the Merlins that have colonized cities such as Saskatoon and prefer crow nests in conifers, the rural Merlins use magpie nests in deciduous trees. Productivity of four young per successful nest is as high as reported anywhere.

Key Words: Merlin, *Falco columbarius richardsonii*, grasslands, Saskatchewan, dieldrin.

Richardson's Merlin, *Falco columbarius richardsonii*, is distinct from other Merlins, since it alone has five very wide white tail bands, paler plumage, a longer wing chord, and a longer tail (Temple 1972). This subspecies suffered a drastic decline in numbers across the prairies and virtually disappeared from the Kindersley area of Saskatchewan, 1962–1975 (Fox 1971). It is fortunate that subsequent *Buteo* studies have also been centered on the Kindersley area, as this is the only locality on the prairies where the decline and resurgence of the Merlin are not purely anecdotal.

Since their resurgence, we have compared and contrasted Merlins nesting in their "native" grassland habitat in thinly-populated rural areas, with the new population of "city Merlins" studied so carefully since 1974 by Oliphant and associates in Saskatoon.

When Bison (*Bison bison*) roamed the plains, Merlins nested in partially wooded river valleys and coulees of rough country, including the margins of the Cypress Hills and Wood Mountain, Saskatchewan (Houston and Schmidt 1981; Oliphant and Thompson 1979). In the first half of this century, Merlins had large clutch sizes. W. J. Brown at Lethbridge, Alberta, between 7 May and 5 June 1904 found eight Merlin nests; he took seven sets of five eggs, and one of six eggs (Bent 1938). Fox (1971) reported that a small sample of Merlins on the Great Plains prior to 1950 had 4.7 eggs per nest ($n = 10$) and 4.3 young per nest ($n = 3$).

Many birders remarked that Merlins declined noticeably in Saskatchewan grasslands in the early 1960s, a decline that was more severe than in adjacent Alberta. The decline was coincident with extensive use of DDT across the continent and with local use of dieldrin* for grasshopper control in adjacent grainfields (Fyfe et al. 1976), but it also coincided with breaking of much previous grassland.

Decline and disappearance, 1958–1962

In grassland habitat near Kindersley, Saskatchewan, Merlin numbers seemed stable with six sites occupied, some for two or three years, in 1958–1960. In eight nests near Kindersley and two near Battleford, followed through the season, during what in retrospect was a period of declining productivity, 45 eggs were laid (4.5 per nest), 27 hatched and 26 were fledged (2.6 young per successful nest) (Fox 1964). By 1962, five of the six previously occupied sites near Kindersley had been deserted; these were in no-longer-occupied farm shelterbelts where the majority of the trees had died and there was a decrease in foliage of surviving trees (Fox 1971). The sole surviving Merlin pair near Kindersley in 1962 was the last to be recorded for ten years. Hodson (1976) in 1972 found a pair of Merlins with a failed nesting attempt 3 km north of Marengo, 42 km west of Kindersley; egg analysis showed persisting high levels (2.78 and 3.24 ppm) of dieldrin. That year he found another occupied Merlin nest in a tributary of the Red Deer River valley, barely within Saskatchewan, a mile north-east of Empress, Alberta.

One of the avowed aims of Hodson's thesis study (1976) was "to probe the cause of the disappearance of Merlins from the Kindersley area." All former Merlin sites near Kindersley were checked by Hodson (1976) in 1972 and by Fox and Hodson in

*Dieldrin is the endo-exo isomer of 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-5,8-dimethanonaphthalene (HEOD).

1974; these and other potentially suitable sites in the area were also checked intermittently by Richard Fyfe through 1975 (personal communication). All three observers failed to find a single nesting pair (Hodson 1976).

In Alberta, with intensive search in 1971-1974, Hodson's active nests at Hanna numbered 19, 29, 18, and 25 per year, and in the river valleys north and west of Medicine Hat, they numbered 9, 16, 10, and 30, respectively; 98 of 709 eggs were taken for analysis of pesticide levels. Hatching success for the remaining eggs was only 57.8%; 84.4% of the hatched young survived to fledging.

Quantification of pesticide use, 1958 - 1965

There are three complementary sources of information about dieldrin usage. First, Robert V. Folker (1970), wildlife ecologist with the Saskatchewan Department of Natural Resources, did a study in 1959 in the Gravelbourg area of south-western Saskatchewan, and sent a circular to 296 municipalities of which 268 or 91% replied. That year 43 Gravelbourg farmers purchased 288 gallons of dieldrin, an average of 6.7 gallons per farmer, and sprayed 8205 acres with 260 gallons, very close to the recommendation of 1 gallon per 32 acres (13 hectares). Of this spraying, 81% was done in June; 20% of the farmers sprayed grassland pasture as well as crops. Province-wide, that year, 12 573 farmers purchased 69 584 gallons of dieldrin, about 5.5 gallons per farmer. [Gallons and acres are cited unconverted as they were the units in use at the time. Dieldrin in 1960 was delivered and sold in five-gallon pails. Land in Saskatchewan is still bought and sold in acres.]

The second source is Hodson's thesis (Hodson 1976), where Table 12 quantified the dieldrin purchased in five villages and towns (Kindersley, Brock, Smiley, Marengo and Glidden) on the western half of the 1:250 000 Kindersley, Saskatchewan, map sheet (Figure 1). Hodson postulated that "the heavy and

widespread use of dieldrin is ... the factor which rendered the coup de grace to the Merlins of the Kindersley area." In Alberta, Hodson found a highly significant relationship between hatching failure and levels of both DDE and dieldrin; unhatched eggs from successful nests had 0.54 ppm of dieldrin, whereas eggs from unsuccessful nests had 0.83 ppm ($p \leq 0.02$).

The annual reports of the Saskatchewan Department of Agriculture from 1951 through 1965, the third source, listed dieldrin gallonage supplied to each rural municipality throughout one grasshopper outbreak and for three years thereafter (Table 1). A small quantity, 500 gallons, of the new chemical was used for grasshopper control in Saskatchewan for the first time in 1951, near Davidson, where the infestation was most severe. For the next six years, grasshopper infestations were minimal throughout the province, and dieldrin was not required. Then, in 1958, 50 000 gallons of dieldrin were used. In 1959, almost 70 000 gallons were sprayed on about two million acres, with residual chemical used the succeeding year. In 1961, the outbreak was unexpectedly severe, requiring airlifts of dieldrin from Toronto; the total distribution was 214 000 gallons. In 1962, about 100 000 gallons of dieldrin were used, estimated to kill 95 to 98% of the grasshoppers. These government figures of dieldrin usage, by municipalities, correspond reasonably closely with Hodson's figures of sales in the main village of each municipality. The department reported there were no deaths to humans or to wildlife linked to this usage.

In 1962, sevin was available as an alternate treatment, and in 1963, dimethoate as well. In 1965, dieldrin was restricted to specified localities, so very little was used. Milk and meat could not be sold if livestock had been fed crops sprayed with dieldrin. Dieldrin was banned in 1966.

In addition to dieldrin, Hodson incriminated

TABLE 1. Sales of dieldrin in five rural municipalities near Kindersley, 1958-1962 (in gallons). From Annual Reports, Saskatchewan Department of Agriculture.

	Price/ gallon	Kindersley RM #290	Prairiedale RM #321	Hillsburgh RM #289	Milton RM #292	Newcombe RM #260	Total	Entire Province
1958	\$5.00	464			12	20	496	51 160
1959	\$4.50	300	56	48	352	300	1056	70 000
1960	\$4.50	928	360	16	1196	120	2620	12 500 *
1961	\$6.00	3195	980	594	2195	1650	8614	214 000
1962	\$5.00	1365	600	550	1220	580	4315	100 000
1963	\$6.00							22 360
1964	\$6.00							10 281
1965	\$6.00							740 restricted
Total		6252	1996	1208	4975	2670	17101	

*= assuming equal quantities of dieldrin and heptachlor.
A gallon is 4.546 litres.

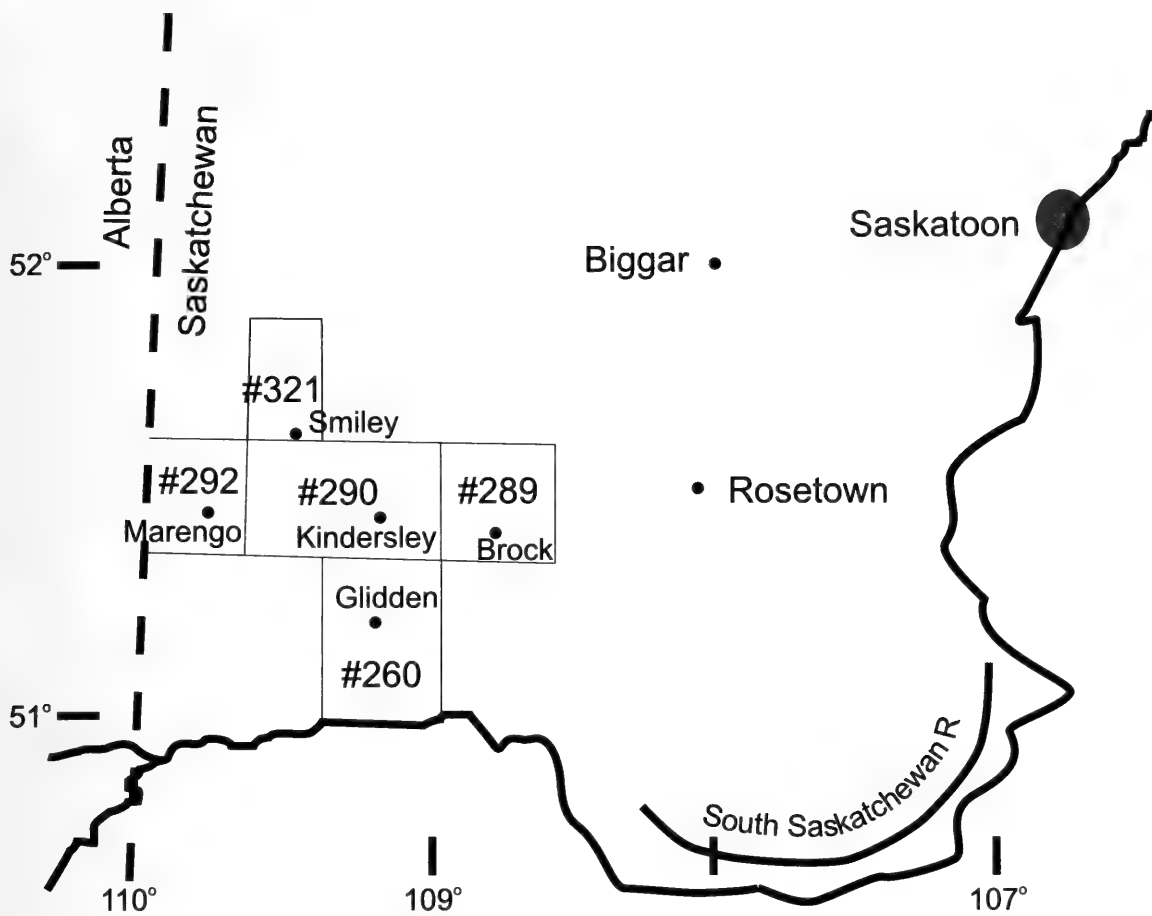


FIGURE 1. Map of Kindersley area, courtesy of Donald S. Houston.

DDT in the productivity decline. The least aggressive adult Merlins had decreased productivity and their eggs had thinner shells (Hodson 1976). A follow-up study in Alberta by Fox and Donald (1980) again showed that eggs with large DDE (the breakdown product of DDT) burdens had significantly thinner shells, disappeared more often, and hatched less frequently than normal.

Habitat

Fox (1971) thought the sudden decline in Merlin numbers might have been accelerated by deterioration and disappearance of trees used as nest sites. Hodson (1976) found no crow, magpie, or hawk nests available for Merlin nest use in 7 of 14 previous Merlin sites near Kindersley. To quantify the disappearance of grasslands, Hodson (1976) compared air photos near Kindersley between 1956 and 1971. In 1956, ten of the 15 historic Merlin territories included more than 50% grassland, whereas by 1971, only 4 of the 15 retained this amount of grassland. Put another way, near Kindersley 52% of the Merlin hunting territories present in the 1940s had been cultivated by 1971. Hodson calculated that 58% of the land within 1.6 km of Merlin nests was under cultivation in 1971, as compared to only 22% at Hanna, Alberta, where Merlins persisted as a breeding species.

Colonization of urban habitat

In the earliest phase of their recovery, Merlins followed the American Crow (*Corvus brachyrhynchos*) and Black-billed Magpie (*Pica pica*) into the cities, where corvid nests became available for city Merlins to use. By 1971 Merlins were regular residents in Saskatoon (Oliphant and McTaggart 1977; Sodhi et al. 1992). Since 1974 intensive studies of both summering and wintering Merlins have been carried out by Oliphant, James, Warkentin, Sodhi, and colleagues (citations in Sodhi et al. 1993), with a continued slow increase in the number of breeding pairs. There are now over 30 pairs resident in Saskatoon each year.

Methods

Post-pesticide productivity at Kindersley

Houston's studies of the Merlins near Kindersley were a by-product of more intense studies of Swainson's (*Buteo swainsoni*) and Ferruginous hawks (*Buteo regalis*) since 1969 in the grasslands within all but the northeast quarter of the 1:250 000 Kindersley map sheet, from 51° to 52° North and from 108° to 110° West. Each known nest of both buteos is visited at least once each year, the Ferruginous in late June and the Swainson's in late July. Over the years, with increased effort, the

TABLE 2. Merlins banded per successful rural nest, 1975–1995.

Nests with	# nests	Total young	% young
1 young	5	5	1.0%
2 young	6	12	2.4%
3 young	20	60	11.8%
4 young	39	156	30.7%
5 young	55	275	54.1%
Total	125	508	100.0%

number of buteo nests under surveillance has gradually increased (Houston and Schmutz 1995). Early visits included government pastures where Merlins were completely absent in the first six years but appeared subsequently. Visits were timed for the two buteo species; sometimes the Merlins were too small for banding at the Ferruginous banding visit but had fledged by the time of the Swainson’s visit.

Results

During Houston’s first six years of Kindersley area studies, 1969-1974 inclusive, no nesting Merlins were encountered. One nesting pair was encountered in each of 1975 and 1976. Since then, Merlins have gradually re-established in the Kindersley area. Since 1975, 508 Merlin nestlings have been banded in 125 rural nests, with productivity of 4.06 young per successful nest. The most common number in a nest at banding time was five young (Table 2). The highest number of rural nests encountered (12) and the highest number of young (51), occurred in 1995, when Swainson’s and Ferruginous hawk productivity were at all-time lows (Houston and Schmutz 1995a, 1995b).

Unlike the Saskatoon Merlins, which prefer previous crow nests in conifers, the Merlins in the Kindersley area seemed to use preferentially the cover provided by previous, roofed magpie nests in deciduous trees (Table 3). However, two Merlin pairs nested on top of the magpie nest, rather than inside the covered nest cup.

Whereas in the city of Saskatoon, males return to the same nest area in a subsequent year 61% of the time, and females 29% of the time (Warkentin et al. 1991), near Kindersley Merlins rarely occupied the same shelterbelt in consecutive years. For example, a deserted farm shelterbelt in the Antelope Park Pasture near Hoosier, always with at least two magpie nests and one crow nest in good condition, had Merlins nesting successfully in 1980, 1981, 1986, 1993, and 1995. Only one other known site in this pasture was used once, in 1988. In the 63.5 km² Kindersley-Elna Pasture, only four of nine abandoned farm groves have been used, and only in 1986 were two groves occupied simultaneously. The

TABLE 3. Merlin nest trees (rural), 1975–1995.

Tree	Former occupant (builder of nest)			
	BBMA	AMCR	SWHA	Total
Maple	54	11	1	66
Aspen	15	6	1	22
Green Ash	11	2		13
Willow sp.	11			11
Elm sp.	4	1		5
Cottonwood	2			2
Saskatoon	2	1		3
Chokecherry	1			1
Spruce	2			2
	102	21	2	125

BBMA – Black-billed Magpie, *Pica pica*
AMCR – American Crow, *Corvus brachyrhynchos*
SWHA – Swainson’s Hawk, *Buteo swainsoni*

first grove was used in 1975 with three successful raptor species quite close together, a Ferruginous Hawk, a Swainson’s Hawk, and a Merlin, and had Merlins again in 1984. A smaller L-shaped grove was used consecutively in 1985 and 1986. Another grove was used once in 1986. The most popular grove was used in 1976, 1982, 1983, 1987, 1988 and finally in 1989 when on 24 June a bigamous male defended both a successful female with well-developed young and another female nearby with newly-hatched, downy young, but the second nest failed before a repeat visit. A fifth site, in trees along the shore of a tiny lake just outside the south edge of the pasture, was used only in 1992. This last nest was remarkable in that magpies were raised inside the nest and Merlins simultaneously were raised on top of the nest.

To date, there have been only seven recoveries (0.8%) from 561 Merlins banded, all but one (after 2.5 years) within the first year after banding. Three distant recoveries were from extreme southern Saskatchewan, Nebraska, and Texas, at distances of 260, 1290, and 2005 km, respectively. The recovery rate here is only one-third of that obtained from banding in Alberta (Schmutz et al. 1991).

Discussion

Although this study relied on a small sample of observations, it indicated that Merlins were virtually absent from grasslands near Kindersley between 1962 and 1975. Disappearance in the 1960s was due largely to pesticide toxicity, probably from both dieldrin and DDT. Since 1975, Merlin populations have gradually recouped in numbers and productivity near Kindersley at the same time as they invaded a number of cities such as Saskatoon, Edmonton, and Winnipeg and, to a lesser degree, Regina.

Grassland Merlins overwhelmingly use nests of the Black-billed Magpie in deciduous trees, whereas

in Saskatoon all 58 nests studied were in conifers and 54 of the 58 had been built by crows (Warkentin and James 1988). It is interesting that in Montana, Merlins use magpie nests in stands of Ponderosa Pine near grassland; Black-billed Magpie nests combine easy access with maximum concealment (Sieg and Becker 1990).

Since 1977, the productivity per rural nest (average number of chicks reaching 15 days of age), has been excellent (4.06), minimally better than the 3.8 reported by Sodhi et al (1992) for the city of Saskatoon. The 44% (55/125) of nests raising five young to banding age is a big improvement over the early Kindersley figures (1958-1960), and from the rural Alberta figures in the early 1970s. More than half of the young in rural Saskatchewan are produced from nests with five young (Table 2). Polygyny, considered rare in this species, has been reported once by us and once in Saskatoon by Sodhi (1989).

Why do the rural Merlins near Kindersley not show the fidelity to nest areas demonstrated by color-banded birds in the city of Saskatoon? One doubts that the high mortality rate for this small falcon, much higher than that for larger hawks, is the explanation; although the mortality in rural areas is unknown, in Saskatoon the annual adult mortality rate is estimated at 31% for males and 29% for females (James et al. 1989). The Saskatoon studies indicate greater dispersal of females, with recoveries of adult females in the breeding season at distances of 71, 123, 231, and 259 km (James et al. 1989), and a color-banded female sighted in Edmonton in 1994 was believed to have originated in Saskatoon (Rick Espie, personal communication). In England, early in this century, Merlin territories tended to be occupied annually, even after removal of previous occupants: on the moors near Skipton, Yorkshire, England, the late William Rowan (1921) reported that on one territory, both individuals of a pair of Merlins were killed by the gamekeeper each year for 19 consecutive years, and yet a pair inevitably replaced them the following year.

Trees on Saskatchewan pastures have deteriorated greatly since the 1960s, and even more grassland has succumbed to the plough, yet in spite of these adverse factors it has been heartening to observe the resurgence of this attractive little falcon. It is indeed fortunate that two raptor enthusiasts were suitably situated to document the decline, confirmed by additional surveys for a thesis project.

Addendum

Houston also banded young in single nests with two and three young discovered incidentally in 1957 and 1958, before Merlin numbers declined, and four young in a river coulee near Beechy, Saskatchewan,

in 1974. Another 43 nestlings in ten nests in cities and large towns (Saskatoon and Nipawin) and in mixed forest areas have been banded; all ten were previous crow nests in spruce trees. Only one adult has been banded.

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Rare and Endangered Fishes and Marine Mammals of Canada: COSEWIC Fish and Marine Mammal Subcommittee Status Reports: XI

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Campbell, R. R. *Editor*. 1997. Rare and endangered fishes and marine mammals of Canada: COSEWIC Fish and Marine Mammal Subcommittee Status Reports: XI. *Canadian Field-Naturalist* 111(2): 249–257.

Six status reports representing the 1996 fish and marine mammal status assignments have been prepared for publication. Committee (COSEWIC) and Subcommittee (Fish and Marine Mammals) activities are briefly discussed as is proposed legislation regarding a Canadian Endangered Species Act. Tabular lists of fish and marine mammal species assigned status to April 1996, reports in progress, and species of possible interest are presented.

Six rapports de statut relativement aux poissons et aux mammifères marins auxquels ont été attribués un statut en 1996 ont été préparés pour publication. Les activités du Comité (CSEMDC) et du sous-comité (des poissons et des mammifères marins) sont brièvement discutées, de même que la proposition législative quant à une Loi sur la protection des espèces en péril au Canada. Les listes sous forme tabulaire des espèces de poisson et de mammifère marin qui ont reçu un statut jusqu'en avril 1996, des rapports en cours, et des espèces qui pourraient être d'intérêt sont présentées.

Key Words: Rare and endangered species, fish, marine mammals, COSEWIC.

As indicated in previous submissions (Campbell 1984 through 1996), the intent of the Subcommittee on Fish and Marine Mammals is to publish the status reports (on those species of fish and marine mammals) which the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has reviewed, approved and used as a basis of assigning status to species in jeopardy in Canada.* The group of six reports presented herein represent the fish and marine mammal component of those species assigned status in 1996 (see Table 1). It is hoped that we will be able to find continuing financial support to offer, in succeeding volumes, those reports reviewed in future years.

In addition to the six reports included here, a seventh species was accorded status at the 1996 General Meeting. The Eelgrass limpet, *Lottia alveus alveus* was declared extinct based on a previously published article by Carlton et al. (1991).

Progress

COSEWIC has undertaken to make available to all Canadians supporting information on each

species classified (*see* Cook and Muir 1984). The Fish and Marine Mammal Subcommittee has been able to use this journal as one step in achieving the goal. A series of reports have appeared in various volumes and numbers from 1984 through 1996 [*see* *Canadian Field-Naturalist* 98(1): 63–133; 99(3): 404–450; 101(2): 165–309; 102(1): 81–176 and 102(2): 270–398; 103(2): 147–220; 104(1): 1–145; 105(2): 151–250; 106(1): 1–72; 107(4): 395–546; 110(3): 454–532].

In April 1996 the Canadian Wildlife Federation (CWF) discontinued support of COSEWIC report preparation, with the exception of the Canadian Wildlife Service contribution of \$10 000, no funding report remains at the time of writing. Negotiation with other Canadian non-governmental agencies such as World Wildlife Fund (Canada) will hopefully result in a matching funding agreement similar to that enjoyed with CWF from 1993 to 1996 (*see* Campbell 1996).

As of April 1996, COSEWIC has reviewed the status of 86 fish species, two marine invertebrates, and 41 marine mammals (Table 1). Of the 129 species investigated six are indeterminate (five fish, one marine mammal), 54 (21 fish, 32 marine mammals, one marine invertebrate) have been found not to require status designation and another 44 (38 fish, six marine mammals) have been designated as vulnerable, mainly due to natural rarity, leaving 24 species of immediate concern (threatened and endangered) which are of interest to the RENEW (Recovery of Nationally Endangered Wildlife) organization which was established in 1990 to oversee the development of recovery teams and plans for

*Publications of Status Reports submitted to other subcommittees, and subsequently approved by COSEWIC, including some mammals, birds, amphibians and reptiles, and plants have not had subcommittee publication support; some have been published in *The Canadian Field-Naturalist* on the individual initiative of their authors. Full original Status Reports for all designated species are available from the Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario, Canada K1A 0H3. Phone (819) 997-4991.

TABLE 1. Fish and Marine Mammal Species with Assigned COSEWIC Status to 19 April 1996.

Species	Scientific Name	Status	Date Assigned
Fish			
Lake Sturgeon	<i>Acipenser fulvescens</i>	NAR ^a	April 1986
Bloater	<i>Coregonus hoyi</i>	NAR	April 1988
Blueback Herring	<i>Alosa aestivalis</i>	NAR	April 1980
Cutlips Minnow	<i>Exoglossum maxillingua</i>	NAR	April 1994
Striped Shiner	<i>Luxilis chyrsocephalus</i>	NAR	April 1993
Redfin Shiner	<i>Lythrurus umbratilis</i>	NAR	April 1988
Hornyhead Chub	<i>Nocomis biguttatus</i>	NAR	April 1988
River Chub	<i>Nocomis micropogon</i>	NAR	April 1988
Ghost Shiner	<i>Notropis buchanani</i>	NAR	April 1993
Blackchin Shiner	<i>Notropis heterodon</i>	NAR	April 1994
Leopard Dace	<i>Rhinichthys falcatus</i>	NAR	April 1990
Mountain Sucker	<i>Catostomus platyrhynchus</i>	NAR	April 1991
Golden Redhorse	<i>Moxostoma erythrurum</i>	NAR	April 1989
Least Darter	<i>Etheostoma microperca</i>	NAR	April 1989
Tesselated Darter	<i>Etheostoma olmstedii</i>	NAR	April 1993
River Darter	<i>Percina shumardi</i>	NAR	April 1989
Green Sunfish	<i>Lepomis cyanellus</i>	NAR	April 1987
Longear Sunfish	<i>Lepomis megalotis</i>	NAR	April 1987
Spoonhead Sculpin	<i>Cottus ricei</i>	NAR	April 1989
Brook Silverside	<i>Labidesthes sicculus</i>	NAR	April 1989
Y-Prickleback	<i>Allolumpenus hypochromus</i>	NAR	April 1991
Darktail Lamprey	<i>Lethenteron alaskense</i>	Indeterminate ^b	April 1990
Bering Cisco	<i>Coregonus laurettae</i>	Indeterminate	April 1990
Flathead Catfish	<i>Pylodictis olivaris</i>	Indeterminate	April 1993
Northern Madtom	<i>Noturus stigmosus</i>	Indeterminate	April 1993
Pixy Poacher	<i>Occella impi</i>	Indeterminate	April 1991
Lake Lamprey ^c	<i>Lampetra macrostoma</i>	Vulnerable	April 1986
Chestnut Lamprey	<i>Ichthyomyzon castaneus</i>	Vulnerable	April 1991
Northern Brook Lamprey	<i>Ichthyomyzon fossor</i>	Vulnerable	April 1991
Shortnose Sturgeon	<i>Acipenser brevirostrum</i>	Vulnerable	April 1980
Green Sturgeon	<i>Acipenser medirostris</i>	Vulnerable	April 1987
White Sturgeon	<i>Acipenser transmontanus</i>	Vulnerable	April 1990
Spotted Gar	<i>Lepisosteus oculatus</i>	Vulnerable	April 1983 ^d
Spring Cisco ^c	<i>Coregonus</i> sp.	Vulnerable	April 1992
Squanga Whitefish ^c	<i>Coregonus</i> sp.	Vulnerable	April 1988
Kiyi	<i>Coregonus kiyi</i>	Vulnerable	April 1987
Pacific Sardine	<i>Sardinops sagax</i>	Vulnerable	April 1987
Redside Dace	<i>Clinostomus elongatus</i>	Vulnerable	April 1987
Silver Chub	<i>Macrhybopsis storeriana</i>	Vulnerable	April 1985
Pugnose Shiner	<i>Notropis anogenus</i>	Vulnerable	April 1985
Bigmouth Shiner	<i>Notropis dorsalis</i>	Vulnerable	April 1985
Silver Shiner	<i>Notropis photogenis</i>	Vulnerable	April 1983 ^e
Roseyface Shiner - Manitoba	<i>Notropis rubellus</i>	Vulnerable	April 1994
Pugnose Minnow	<i>Opsopoeodus emiliae</i>	Vulnerable	April 1985
Speckled Dace	<i>Rhinichthys osculus</i>	Vulnerable	April 1980 ^f
Umatilla Dace	<i>Rhinichthys umatilla</i>	Vulnerable	April 1988
Central Stoneroller	<i>Campostoma anomalum</i>	Vulnerable	April 1985
Banded Killifish -Newfoundland	<i>Fundulus diaphanus</i>	Vulnerable	April 1989
Blackstripe Topminnow	<i>Fundulus notatus</i>	Vulnerable	April 1985
Lake Chubsucker	<i>Erimyzon sucetta</i>	Vulnerable	April 1994
Bigmouth Buffalo	<i>Ictiobus cyprinellus</i>	Vulnerable	April 1989
Black Buffalo	<i>Ictiobus niger</i>	Vulnerable	April 1989
Spotted Sucker	<i>Minytrema melanops</i>	Vulnerable	April 1983 ^d
River Redhorse	<i>Moxostoma carinatum</i>	Vulnerable	April 1983 ^f
Greenside Darter	<i>Etheostoma blennioides</i>	Vulnerable	April 1990
Brindled Madtom	<i>Noturus miurus</i>	Vulnerable	April 1985
Redbreast Sunfish	<i>Lepomis auritus</i>	Vulnerable	April 1989
Warmouth	<i>Lepomis gulosus</i>	Vulnerable	April 1994
Orangespotted Sunfish	<i>Lepomis humilis</i>	Vulnerable	April 1989
Fourhorn Sculpin - Arctic Islands	<i>Myoxocephalus quadricornis</i>	Vulnerable	April 1989

TABLE 1. Continued.

Species	Scientific Name	Status	Date Assigned
Giant Stickleback ^c	<i>Gasterosteus</i> sp.	Vulnerable	April 1980
Unarmoured Stickleback ^c	<i>Gasterosteus</i> sp.	Vulnerable	April 1983
Blackline Prickleback	<i>Acantholumpenus mackayi</i>	Vulnerable	April 1989
Bering Wolffish	<i>Anarichus orientalis</i>	Vulnerable	April 1989
Lake Simcoe Whitefish ^c	<i>Coregonus clupeaformis</i> ssp.	Threatened	April 1987
Blackfin Cisco	<i>Coregonus nigripinnis</i>	Threatened	April 1988
Shortnose Cisco	<i>Coregonus reighardi</i>	Threatened	April 1987
Shortjaw Cisco	<i>Coregonus zenithicus</i>	Threatened	April 1987
Black Redhorse	<i>Moxostoma duquesnei</i>	Threatened	April 1988
Copper Redhorse ^c	<i>Moxostoma hubbsi</i>	Threatened	April 1987
Eastern Sand Darter	<i>Ammocrypta pellucida</i>	Threatened	April 1994
Channel Darter	<i>Percina copelandi</i>	Threatened	April 1993
Margined Madtom	<i>Noturus insignis</i>	Threatened	April 1989
Enos Lake Stickleback ^c	<i>Gasterosteus</i> sp.	Threatened	April 1988
Shorthead Sculpin	<i>Cottus confusus</i>	Threatened	November 1983
Deepwater Sculpin - Great Lakes	<i>Myoxocephalus thompsoni</i>	Threatened	April 1987
Acadian Whitefish ^c	<i>Coregonus huntsmani</i>	Endangered	April 1983
Aurora Trout ^c	<i>Salvelinus fontinalis timagamiensis</i>	Endangered	April 1987
Nooksack Dace	<i>Rhinichthys cataractae</i> ssp.	Endangered	April 1996
Salish Sucker	<i>Catostomus</i> sp.	Endangered	April 1986
Paddlefish	<i>Polyodon spathula</i>	Extirpated	April 1987
Gravel Chub	<i>Erimystax x-punctata</i>	Extirpated	April 1987 ^g
Longjaw Cisco	<i>Coregonus alpenae</i>	Extinct	April 1988
Deepwater Cisco	<i>Coregonus johannae</i>	Extinct	April 1988
Banff Longnose Dace ^c	<i>Rhinichthys cataractae smithi</i>	Extinct	April 1987
Blue Walleye	<i>Stizostedion vitreum glaucum</i>	Extinct	April 1985
Marine Molluscs			
Northern Abalone	<i>Haliotis kamtschatkana</i>	N/A ^h	April 1988
Eelgrass Limpet	<i>Lottia alveus alveus</i>	Extinct	April 1996
Marine Mammals			
Sea Otter	<i>Enhydra lutris</i>	Threatened	April 1996 ⁱ
Sea Mink	<i>Mustela macrodon</i>	Extinct	April 1985
Northern Fur Seal	<i>Callorhinus ursinus</i>	NAR	April 1996
Hooded Seal	<i>Cystophora cristata</i>	NAR	April 1986
Bearded Seal	<i>Erignathus barbatus</i>	NAR	April 1994
Northern Elephant Seal	<i>Mirounga angustirostris</i>	NAR	April 1986
Ringed Seal	<i>Phoca hispida</i>	NAR	April 1989
Harbour Seal	<i>Phoca vitulina mellonae</i>	Vulnerable	April 1996
Lac des Loups Marins			
Steller Sea Lion	<i>Eumetopias jubatus</i>	NAR	April 1987
California Sea Lion	<i>Zalophus californianus</i>	NAR	April 1987
Atlantic Walrus	<i>Odobenus rosmarus rosmarus</i>		
Eastern Arctic		NAR	April 1987
Northwest Atlantic		Extirpated	April 1987
Baird's Beaked Whale	<i>Berardius bairdi</i>	NAR	April 1992
Beluga	<i>Delphinapterus leucas</i>		
Beaufort Sea		NAR	April 1986
Western and Southern Hudson Bay		NAR	April 1993
High Arctic		Vulnerable	April 1992
Eastern Hudson Bay		Threatened	April 1988
St. Lawrence River		Endangered	April 1983
S.E. Baffin Island		Endangered	April 1990
Ungava Bay		Endangered	April 1988
Common Dolphin	<i>Delphinus delphis</i>	NAR	April 1991
Grey Whale	<i>Eschrichtius robustus</i>		
Northeast Pacific		NAR	April 1987
Northwest Atlantic		Extirpated	April 1987
Risso's Dolphin	<i>Grampus griseus</i>	NAR	April 1990
Short-finned Pilot Whale	<i>Globicephala macrohynchus</i>	NAR	April 1993

TABLE 1. *Concluded.*

Species	Scientific Name	Status	Date Assigned
Long-finned Pilot Whale	<i>Globicephela malaena</i>	NAR	April 1994
Northern Bottlenose Whale	<i>Hyperoodon ampullatus</i>		
Northwest Atlantic		NAR	April 1993
Gully Population		Vulnerable	April 1996
Pygmy Sperm Whale	<i>Kogia breviceps</i>	NAR	April 1994
Atlantic White-sided Dolphin	<i>Lagenorhynchus acutus</i>	NAR	April 1991
Pacific White-sided Dolphin	<i>Lagenorhynchus obliquidens</i>	NAR	April 1990
Northern Right Whale Dolphin	<i>Lissodelphis borealis</i>	NAR	April 1990
Hubbs' Beaked Whale	<i>Mesoplodon carlhubbsi</i>	NAR	April 1989
Blainville's Beaked Whale	<i>Mesoplodon densirostris</i>	NAR	April 1989
True's Beaked Whale	<i>Mesoplodon mirus</i>	NAR	April 1989
Stejneger's Beaked Whale	<i>Mesoplodon stejnegeri</i>	NAR	April 1989
Narwhal	<i>Monodon monoceros</i>	NAR	April 1986 ^e
Dall's Porpoise	<i>Phocoenoides dalli</i>	NAR	April 1989
False Killer Whale	<i>Pseudorca crassidens</i>	NAR	April 1990
Sperm Whale	<i>Physeter macrocephalus</i>	NAR	April 1996
Striped Dolphin	<i>Stenella coeruleoalba</i>	NAR	April 1993
Bottlenose Dolphin	<i>Tursiops truncatus</i>	NAR	April 1993
Cuvier's Beaked Whale	<i>Ziphius cavirostris</i>	NAR	April 1990
Blue Whale	<i>Balaenoptera musculus</i>	Vulnerable	April 1983 ^f
Fin Whale	<i>Balaenoptera physalus</i>	Vulnerable	April 1987
Sowerby's Beaked Whale	<i>Mesoplodon bidens</i>	Vulnerable	April 1989
Harbour Porpoise	<i>Phocoena phonoeca</i>		
Northwest Pacific		Indeterminate	April 1991
Northwest Atlantic		Threatened	April 1990
Humpback Whale	<i>Megaptera novaeangliae</i>		
Northwest Atlantic		Vulnerable	April 1985
Northeast Pacific		Threatened	April 1982 ^j
Bowhead Whale	<i>Balaena mysticetus</i>	Endangered	April 1980 ⁱ
Right Whale	<i>Eubalaena glacialis</i>	Endangered	April 1980 ^k

^aNAR The use of NIAC (Not in Any Category) was discontinued in 1988 and replaced by RANS DR (Report Accepted No Status Designation Required - not a category of risk). Species previously designated as NIAC were converted to RANS DR at the April 1989 meeting on the recommendation of the subcommittee. The Committee approved the use of a category to be known as species Not At Risk (NAR) at the April 1994 meeting. All species previously designated RANS DR were converted to NAR at the April 1995 meeting as recommended by the subcommittee (*see* Campbell 1996).

^bIndeterminate - The use of a new list, "Report Accepted Insufficient Scientific Information For Status Designation" (RAISIFSD), was approved at the 1990 General Meeting. The Committee agreed to establish this as the "Indeterminate" (I) category at the April 1994 meeting. Species previously listed as RAISIFSD were converted to Indeterminate at the April 1995 meeting on the advice of the subcommittee (*see* Campbell 1996).

^cEndemic to Canada

^dUpdated April 1994 no status change.

^eUpdated April 1987 no status change.

^fUpdated April 1984 no status change.

^gUpdated April 1987 previous status of "Endangered" assigned April 1985.

^hN/A Status Not Assigned. Until 1994 COSEWIC had no mandate for invertebrates. Report accepted and recommended RANS DR Status agreed to, but not assigned. An updated report is in progress.

ⁱEndangered 1978 - updated April 1996 no status change.

^jUpdated April 1985 North Atlantic stock downlisted to "Vulnerable".

^kUpdated April 1985 and April 1990 no status change.

^lUpdated April 1996 - downlisted to "Threatened".

such species listed by COSEWIC (CWS 1993). To date, recovery plans have been produced and implemented only for the St. Lawrence River Beluga. Recovery teams are in the process of development of recovery plans for the Gully population of the Northern Bottlenose Whale and Harbour Porpoise.

There are currently 37 status reports on fish

species (includes eight updates), one marine mollusc (update), and 11 on marine mammal species (three updates) under review or in preparation (Table 2). Several of these will be presented to the Committee for status assignment in 1997. As well, some 78 additional species of fish (plus eight to be updated), one marine mammal (plus one update) and 12

TABLE 2. Fish and Marine Mammal Species for which Status Reports are in preparation, or under review - to 19 April 1996.

Species	Scientific Name	Proposed Status
Fish		
Shortnose Sturgeon°	<i>Acipenser brevirostrum</i>	Vulnerable April 1980
Atlantic Sturgeon	<i>Acipenser oxyrhynchus</i>	?
Lake Sturgeon°	<i>Acipenser fulvescens</i>	?
Atlantic Cod	<i>Gadus morhua</i>	?
Blueback Herring°	<i>Alosa aestivalis</i>	NAR April 1980
Red (Arctic) Char	<i>Salvelinus alpinus</i> ssp.	?
Bull Trout	<i>Salvelinus confluentus</i>	Vulnerable
Mira Whitefish*	<i>Coregonus</i> sp.	Vulnerable
Opeongo Whitefish*	<i>Coregonus</i> sp.	Threatened
Lake Cisco	<i>Coregonus artedi</i>	Endangered
Lake Whitefish	<i>Coregonus clupeaformis</i>	Threatened - Lake Erie, ON
Acadian Whitefish*°	<i>Coregonus huntsmani</i>	Endangered April 1983
Pygmy Whitefish	<i>Prosopium coulteri</i>	?
Round Whitefish	<i>Prosopium cylindraceum</i>	Vulnerable
Pygmy Smelt	<i>Osmerus spectrum</i>	Vulnerable
Pygmy Longfin Smelt*	<i>Spirinichus thaleichthys</i>	Vulnerable - BC
Redfin Pickerel	<i>Esox americanus americanus</i>	Vulnerable - Quebec
Grass Pickerel	<i>Esox americanus vermiculatus</i>	Vulnerable
Chain Pickerel	<i>Esox niger</i>	Vulnerable - PQ, NB, NS
Chiselmouth	<i>Acrocheilus alutaceus</i>	Vulnerable - BC
Central Stoneroller°	<i>Campostoma anomalum</i>	Vulnerable April 1985
Liard Hotspring Lake Chub*°	<i>Couesius plumbeus</i> ssp.	Vulnerable - BC
Western Silvery Minnow	<i>Hybognathus argyritis</i>	?
Eastern Silvery Minnow	<i>Hybognathus nuchalis regius</i>	Vulnerable
Weed Shiner	<i>Notropis texanus</i>	Vulnerable
Bluntnose Minnow	<i>Pimphales notatus</i>	Vulnerable
Speckled Dace°	<i>Rhinichthys osculus</i>	Vulnerable April 1980
Jasper Longnose Sucker*	<i>Castostomus castostomus lacustris</i>	Vulnerable
Striped Bass	<i>Morone saxatilis</i>	Endangered - PQ
Spinynose Sculpin	<i>Asemichthys taylori</i>	Vulnerable - BC
Cultus Pygmy Coastrange Sculpin*	<i>Cottus aleuticus</i>	Threatened - BC
Mottled Sculpin	<i>Cottus bairdi</i>	Vulnerable - BC, Alberta
Shorthead Sculpin°	<i>Cottus confusus</i>	Vulnerable
Giant Stickleback*°	<i>Gasterosteus</i> sp.	Vulnerable April 1980
Unarmoured Stickleback*°	<i>Gasterosteus</i> sp.	Vulnerable April 1983
Texada Stickleback*	<i>Gasterosteus</i> sp.	Vulnerable
Bluefin Tuna	<i>Thunnus thynnus</i>	?
Marine Molluscs		
Northern Abalone°	<i>Haliotis kamtschatkana</i>	?
Marine Mammals		
Minke Whale	<i>Balaenoptera acutorostrata</i>	?
Sei Whale	<i>Balaenoptera borealis</i>	?
Bowhead Whale°	<i>Balaena mysticetus</i>	Endangered
Blue Whale°	<i>Balaenoptera musculus</i>	Vulnerable
Beluga°	<i>Delphinapterus leucas</i>	
St. Lawrence River		Endangered April 1983
Ungava Bay		Endangered April 1988
Dwarf Sperm Whale	<i>Kogia simus</i>	Vulnerable
White-beaked Dolphin	<i>Lagenorhynchus albirostris</i>	?
Killer Whale	<i>Orcinus orca</i>	?
Grey Seal	<i>Halichoerus grypus</i>	?
Harp Seal	<i>Phoca groenlandica</i>	?

*Endemic to Canada ON = Ontario BC = British Columbia
°Updated Status Report PQ = Quebec NS = Nova Scotia NB = New Brunswick

marine invertebrates have been identified as being worthy of consideration (Table 3). Many may be found to not require status designation, but the process serves to bring together the information necessary to make the appropriate determination and satisfy the need to fill those knowledge gaps. Although

TABLE 3. Fish and Marine Mammal Species of Possible Interest to COSEWIC - April 1996 (Not listed by Priority).

Species	Scientific Name	Possible Status	
Species Updates			
Fish			
Lake Lamprey	<i>Lampeta macrostoma</i>	Vulnerable	April 1986
Silver Chub	<i>Macrhybopsis storeriana</i>	Vulnerable	April 1985
Bigmouth Shiner	<i>Notropis dorsalis</i>	Vulnerable	April 1985
Pugnose Minnow	<i>Opsopoedus emiliae</i>	Vulnerable	April 1985
Pugnose Shiner	<i>Notropis anogenus</i>	Vulnerable	April 1985
Salish Sucker	<i>Catostomus</i> sp.	Endangered	April 1986
Blackstripe Topminnow	<i>Fundulus notatus</i>	Vulnerable	April 1985
Brindled Madtom	<i>Noturus miurus</i>	Vulnerable	April 1985
Marine Mammals			
Humpback Whale	<i>Megaptera novaeangliae</i>		
Northwest Atlantic		Vulnerable	April 1985
Northeast Pacific		Threatened	April 1982+
Species Yet to be Considered			
Fish			
Spiny Dogfish	<i>Squalus acanthias</i>		?
Smooth Skate	<i>Malacoraja senta</i>		?
Thorny Skate	<i>Raja radiata</i>		?
American Eel	<i>Anquilla rostrata</i>	Vulnerable	
American Shad	<i>Alosa sapidissima</i>		?
Atlantic Herring	<i>Clupea harengus</i>		?
Creek Chubsucker	<i>Erimyzon oblongus</i>	Extirpated	?
Brassy Minnow	<i>Hybognathus hankinsoni</i>		?
Pearl Dace	<i>Margariscus margarita</i>	Vulnerable - BC	
Emerald Shiner	<i>Notropis atherinoides</i>	Vulnerable - BC	
Bridle Shiner	<i>Notropis bifrenatus</i>	Vulnerable	
Spottail Shiner	<i>Notropis hudsonius</i>	Vulnerable - BC	
Creek Chubsucker	<i>Erimyzon oblongatus</i>		?
Stonecat	<i>Noturus flavus</i>	? - Alberta	
Capelin	<i>Mallotus villotus</i>	?	
Broad Whitefish	<i>Coregonus nasus</i>	Vulnerable - BC	
Least Cisco	<i>Coregonus sardinella</i>	Vulnerable - BC	
Giant Pygmy Whitefish	<i>Prosopium</i> sp.?	Threatened - BC	
Pacific Salmonids	<i>Oncorhynchus</i> spp. (5 species)		?
Atlantic Salmon	<i>Salmo salar</i>		?
Monkfish	<i>Lophius americanus</i>		?
Tomcod	<i>Microgadus tomcod</i>	Vulnerable - Quebec	
Haddock	<i>Melanogrammus aeglefinus</i>		?
Silver Hake	<i>Merluccius bilinearis</i>		?
Pollock	<i>Pollachius virens</i>		?
Red Hake	<i>Urophycis chuss</i>		?
Rock Grenadier	<i>Coryphaenoides rupestris</i>		?
Balkwill Lake Benthic Stickleback	<i>Gasterosteus</i> sp.	Vulnerable - BC	
Balkwill Lake Limnetic Stickleback	<i>Gasterosteus</i> sp.	Vulnerable - BC	
Emily Lake Benthic Stickleback	<i>Gasterosteus</i> sp.	Vulnerable - BC	
Emily Lake Limnetic Stickleback	<i>Gasterosteus</i> sp.	Vulnerable - BC	
Hadley Lake Benthic Stickleback	<i>Gasterosteus</i> sp.	Vulnerable - BC	
Hadley Lake Limnetic Stickleback	<i>Gasterosteus</i> sp.	Vulnerable - BC	
Paxton Lake Benthic Stickleback	<i>Gasterosteus</i> sp.	Threatened - BC	
Paxton Lake Limnetic Stickleback	<i>Gasterosteus</i> sp.	Threatened - BC	
Priest Lake Benthic Stickleback	<i>Gasterosteus</i> sp.	Threatened - BC	
Priest Lake Limnetic Stickleback	<i>Gasterosteus</i> sp.	Threatened - BC	
Ninespine Stickleback	<i>Pungitius pungitius</i>	Vulnerable - BC	
Pacific Ocean Perch	<i>Sebates alutus</i>		?
Aurora Rockfish	<i>Sebastes aurora</i>		?
Redbanded Rockfish	<i>Sebastes babcocki</i>		?
Silvergray Rockfish	<i>Sebastes brevispinis</i>		?
Copper Rockfish	<i>Sebastes caurinus</i>		?

TABLE 3. *Concluded.*

Species	Scientific Name	Proposed Status
Fish		
Splitnose Rockfish	<i>Sebastes diploproa</i>	?
Widow Rockfish	<i>Sebastes entomelas</i>	?
Chilipepper	<i>Sebastes goodei</i>	?
Shortbelly Rockfish	<i>Sebastes jordani</i>	?
Quillback Rockfish	<i>Sebastes maliger</i>	?
Black Rockfish	<i>Sebastes melanops</i>	?
Vermillion Rockfish	<i>Sebastes miniatus</i>	?
Blue Rockfish	<i>Sebastes mystinus</i>	?
China Rockfish	<i>Sebastes nebulosus</i>	?
Golden Rockfish	<i>Sebastes norvegicus</i>	?
Bocaccio	<i>Sebastes paucispinis</i>	?
Canary Rockfish	<i>Sebastes pinniger</i>	?
Yelloweye Rockfish	<i>Sebastes ruberrimus</i>	?
Stipetail Rockfish	<i>Sebastes saxicola</i>	?
Shortspine Thornyhead	<i>Sebastolobus alascanus</i>	?
Longspine Thornyhead	<i>Sebastolobus altivelis</i>	?
Lingcod	<i>Ophiodon elongatus</i>	?
Rainbow Darter	<i>Etheostoma caeruleum</i>	?
Lumpfish	<i>Cyclopterus lumpus</i>	?
Wolffish	<i>Anarhichas lupus</i>	?
Atlantic Mackerel	<i>Scomber scombrus</i>	?
Swordfish	<i>Xiphias gladius</i>	?
Summer Flounder	<i>Paralichthys dentatus</i>	?
Witch Flounder	<i>Glyptocephalus cynoglossus</i>	?
American Plaice	<i>Hippoglossoides platessoides</i>	?
Atlantic Halibut	<i>Hippoglossus hippoglossus</i>	?
Pacific Halibut	<i>Hippoglossus steolepis</i>	?
Yellowtail Flounder	<i>Limanda ferrugineus</i>	?
Winter Flounder	<i>Pseudopleuronectes americanus</i>	?
Greenland Halibut (Turbot)	<i>Reinhardtius hippoglossoides</i>	?
Marine Mammals		
Harbour Seal	<i>Phoca vitulina</i>	?
Marine Invertebrates		
Crustaceans		
Aesop Shrimp	<i>Pandalus montagui</i>	?
Atlantic Rock Crab	<i>Cancer irroratus</i>	?
Atlantic Lyre Crab	<i>Hyas araneus</i>	?
King Crab	<i>Neolithodes grimaldi</i>	?
Molluscs		
Iceland Scallop	<i>Chlamys islandica</i>	?
Blue Mussel	<i>Mytilus edulis</i>	?
Softshell Clam	<i>Mya arenaria</i>	?
Arctic Surfclam	<i>Mactromeris polynyma</i>	?
Atlantic Surfclam	<i>Spisula solidissima</i>	?
Ocean Quahog	<i>Arctica ilandica</i>	?
Waved Whelk	<i>Buccinum undatum</i>	?
Northern Shortfin Squid	<i>Illex illecebrosus</i>	?

+Updated April 1985 North Atlantic stock downlisted to Vulnerable.

some of these may be of no immediate concern, the Subcommittee will, as opportunity allows, attempt to document these species to determine their status in Canada.

In addition to soliciting further status reports on species of concern, the Subcommittee continues to

obtain updates on the status of selected species as new information becomes available, or in the 10-year review process initiated in 1993 (Table 3) for those species which had not already received further examination following their initial status assignment.

The Canadian Endangered Species Protection Act: A Legislative Proposal

The Canadian Government is considering proposals for the establishment of a *Canadian Endangered Species Protection Act* which could be in place by 1997. The goal of the Act and the processes which flow from it would be to prevent wild Canadian species from becoming extinct (as a consequence of human activities) and to recover species where possible and economically feasible. It is built around and would embody the COSEWIC framework and provide a legal status to its mandate (*see* Environment Canada 1995). However, the Act would apply only to species within the federal mandate (In Canada, as a result of the listing of federal and provincial powers in the British North America Act and recapitulated in the Constitution, wildlife is the property of the province or territory in which it resides, except for those species explicitly under the federal mandate; i.e., fish and marine mammals and migratory birds.), and would also exclude native peripheral species. Most invertebrates, vascular plants, mosses, lichens, reptiles, amphibians, non-migratory birds, and terrestrial mammals do not fall under a federal mandate and given the scope of the proposed Act, it is difficult to see how these would ever get any national consideration by COSEWIC in its new form, given that they would only be of provincial interest.

With the current economic climate, the restraints on government resources from within and without, and the lack of provincial will in the national interest, there is some fear that the enablement of the legislation as proposed would set wildlife conservation in Canada back forty years.

Concluding Remarks

The six reports included in the following series are reports on the status of the respective species in Canada. Status was assigned by consensus of the COSEWIC Committee based on these reports which are published under the name(s) of the original author(s). The reports have undergone minor editing to provide a brief introduction and some degree of consistency in format and presentation.

As to the legislative proposal for a Canadian Endangered Species Act, one should not be overly pessimistic to such a colloquial Canadian bureaucratic approach to the situation. Canadians are great infighters and when a job is to be done, a way will be found to do it. Just look at COSEWIC and what it has achieved in 20 years without any legislative basis or legal mandate.

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Status of the Nooksack Dace, *Rhinichthys* sp., in Canada*

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McPhail, J. D. 1997. Status of the Nooksack Dace, *Rhinichthys* sp., in Canada. *Canadian Field-Naturalist*. 111(2): 258–262.

The Nooksack Dace (*Rhinichthys* sp.) is a morphologically distinctive form derived from the common, widely distributed Longnose Dace, *Rhinichthys cataractae*. Like the Salish Sucker (*Catostomus* sp.), it is a component of the Chehalis fauna. This fauna survived the last glaciation in the ice-free area west of the Cascade Mountains and north of the Columbia drainage system. In Canada, the Nooksack Dace is confined to four small streams tributary to the Nooksack River in the Abbotsford, Aldergrove and Clearbrook areas of the lower Fraser Valley, southwestern British Columbia. The adult habitat is riffles, typically with water velocities close to 0.25 m-sec and a loose, coarse gravel substrate. Young-of-the-year inhabit shallow margins at the tail-ends of pools with mud/sand substrates, and typically recruit to the adult habitat after one year. Although the Nooksack Dace is still moderately common, suitable habitat is deteriorating rapidly through explosive urbanization and gravel extraction in the headwaters of the streams. In western Washington state, the Nooksack Dace is widespread and in no immediate danger but, in Canada, given its restricted distribution and deteriorating habitat it is endangered.

Le naseux de la Nooksack (*Rhinichthys* sp.) est une forme morphologiquement distincte dérivée d'un poisson commun, largement réparti, le naseux des rapides (*Rhinichthys cataractae*). Comme le meunier de Salish (*Catostomus* sp.), il fait partie de la faune du Chehalis, faune qui a survécu à la dernière glaciation dans des espaces libres de glace, à l'ouest des Cascade Mountains et au nord du bassin hydrographique du Columbia. Au Canada, le naseux de la Nooksack est confiné à quatre ruisseaux tributaires de la rivière Nooksack, dans les secteurs d'Abbotsford, d'Aldergrove et de Clearbrook de la partie inférieure de la vallée du Fraser, dans le sud-ouest de la Colombie Britannique. Comme habitat, les adultes adoptent les rapides, particulièrement ceux qui ont une vitesse de près de 0,25 m/s avec des substrats de gros gravier meuble. Les jeunes de l'année habitent les recoins peu profonds, aux substrats de boue sablonneuse, en marge des étangs, et se retrouvent naturellement dans l'habitat des adultes après une année. Même si le naseux de la Nooksack est relativement commun, son habitat de prédilection se détériore rapidement à cause d'une urbanisation frénétique et de l'extraction de gravier à la source des cours d'eau. Dans l'ouest de l'état de Washington, le naseux de la Nooksack est très répandu et ne court aucun danger immédiat, mais au Canada, vu sa faible distribution et le déclin de son habitat, il est en danger de disparition.

Key Words: Nooksack Dace, naseux de la Nooksack, *Rhinichthys* sp., cyprinids, endangered species, British Columbia.

The Nooksack Dace (*Rhinichthys* sp.) is a small (up to about 105 mm in standard length) cyprinid fish widely distributed in the clear, relatively rapid rivers and streams of western Washington (McPhail 1967). In Canada, it is restricted to a few small tributaries of the Nooksack River in the lower Fraser Valley, southwestern British Columbia (McPhail and Lindsey 1986). It is a slim fish with a snout that clearly overhangs the mouth, a streamlined back and a flattened underside (Figure 1). In life, adults are grey-green above with a dull brassy stripe just above the lateral line. The sides below the lateral line are dirty white grading into silver-white on the underparts. Often there are scattered dusky speckles on the sides below the lateral line and a black stripe on the head in front of the eyes. Viewed from above, there is a distinct pale mark at the anterior and posterior base of the dorsal fin. There is no striking sexual dimorphism in colour, but males have conspicuously longer, and darker, pectoral fins than females. In juveniles there is a

conspicuous black mid-lateral stripe that extends from the snout back to a diffuse dark spot at the base of the tail.

Distribution

This distributional account is based on collections in the fish museums of the Department of Zoology, University of British Columbia, and the School of Fisheries, University of Washington. The geographic distribution of the Nooksack Dace forms a rough fish-hook around Puget Sound (Figure 2) although, curiously, it is absent from rivers on the west side of the Sound. On the west side of the Olympic Peninsula it occurs from the Queets system in the north to the Willapa River in the south. On the east side of Puget Sound it extends from the Pyullup River in the south to the Nooksack River in the north. The species is widespread in the Chehalis system, but so far is unrecorded from the Deschutes and Nisqually rivers near Olympia, Washington. In Canada, the

*Reviewed and approved by COSEWIC 16 April 1996 —status assigned: Endangered.

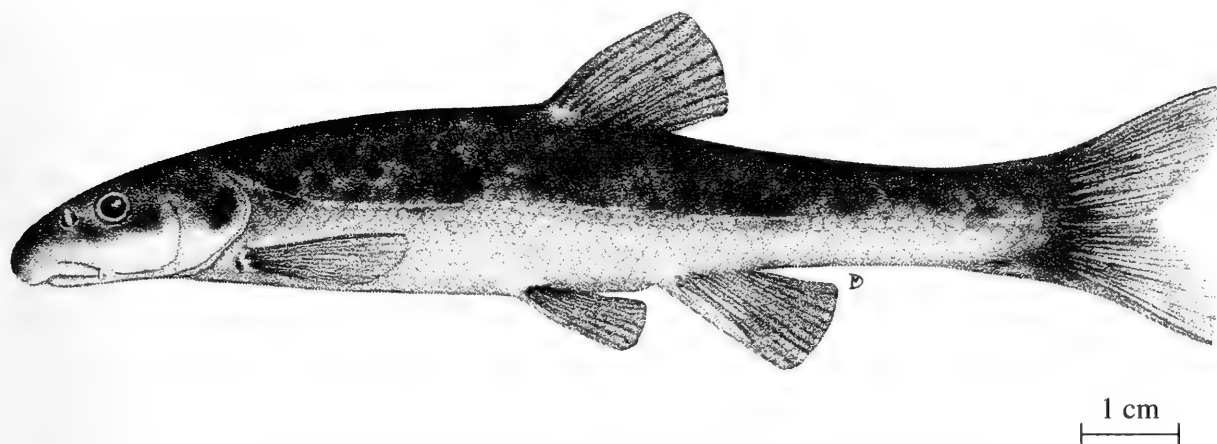


FIGURE 1. Nooksack Dace, *Rhinichthys* sp., 81 mm standard length.

Nooksack Dace is restricted to Nooksack tributaries in the lower Fraser Valley of British Columbia; Bertrand, Cave, Fishtrap and Pepin creeks (see inset Figure 2).

Protection

No special protection is in place for the Nooksack Dace; however, its Canadian distribution lies entirely within the range of the Salish Sucker (*Catostomus* sp.), a species assigned "Endangered" status in April of 1986 by COSEWIC and in British Columbia, allocated to the Ministry of Environment's critically imperiled category. Consequently, measures taken by the B.C. Ministry of Environment, Lands and Parks to protect the Salish Sucker also protect the Nooksack Dace.

Population Sizes and Trends

Although the geographic distribution of the Nooksack Dace in Canada is limited, museum records from the 1960s suggest that the species once was abundant within this restricted range. Unfortunately, no formal estimates of past, or present, numbers are available for the Nooksack Dace; however, an October 1993 survey of five riffles in Bertrand Creek revealed an average density of 1.4 (SE = ± 0.24) adults m^2 . Furthermore, the populations in Bertrand, Cave, Fishtrap and Pepin creeks appear healthy: a range of year classes is present in each of the creeks, including substantial numbers of young-of-the-year, although in 1993 the 1+ year class was under represented both in our survey and in a summer survey supported by the Habitat Conservation Fund (S. Inglis, B.C. Ministry of Environment, Lands and Parks, Victoria, British Columbia; personal communication). Even though the existing populations appear healthy, there is evidence that suggests the British Columbia distribution is shrinking. For example, Nooksack Dace are now absent from some of the smaller tributaries (e.g., Howes Creek) and headwaters of both Bertrand and Fishtrap creeks where they occurred in the 1960s. In

these creeks, rapid urbanization in the Aldergrove, Clearbrook and Abbotsford regions has increased siltation, pollution and fluctuations in discharge. The result is deteriorating water quality and a loss of habitat that is spreading downstream. Near the United States border, the streams are in better condition. Here, they flow through a rural landscape, but even in this area land clearing and gravel extraction generate silt and decrease summer flows. By late August most small tributaries are dry and, in drought years, even the main creeks (Bertrand and Fishtrap) are reduced to trickles. Since adult Nooksack Dace depend on riffles with loose gravel substrate for foraging and breeding (see sections on Habitat and General Biology), silt and low summer flows are especially harmful to this species. Low summer flows restrict adult habitat at the most productive time of the year by reducing the riffle areas, and silt tends to fill the interstices between rocks and cement them into the substrate. This reduces both the cover available to adults and their foraging opportunities. Under low water conditions, adults will shift into pools but they probably do not grow or survive as well in this marginal habitat as they do in riffles. Consequently, given that the demand for both housing and gravel in the lower Fraser Valley will continue to increase, habitat suitable for adult Nooksack Dace will continue to decrease and the species probably will go extinct in Canada in the next one or two decades.

Habitat

Adult Nooksack Dace are demersal and typically occur in riffles with water velocities greater than $0.25 m^{-sec}$ and a substrate of loose gravel (4-10 cm in diameter), cobbles, or boulders. In Canada, the species is associated with small to moderate sized streams (1 to 4 m in width); however, this association probably simply reflects the absence of large Nooksack tributaries in Canada; whereas in Washington, the species regularly occur in large rivers. In contrast to adults, young-of-the-year are

TABLE 1. Habitat differences between adult and young-of-year Nooksack Dace, *Rhinichthys* sp., Bertrand Creek, 1 October 1993.

	Adults	Young-of-year
Average Water Veocities	0.34 ± 0.039 m ^{-sec}	014 ± 0.022 m ^{-sec}
Substrate	fist-sized gravel, cobbles and boulders	mud, sand, leaf litter

associated with slow water (0.14 ± 0.022m^s near the downstream ends of pools (Table 1). Here, the young occur in shallow water (about 10 to 20 cm deep) but swim above the sand or mud substrate. Thus, the species occupies two basic stream habitats: adults in fast water over loose rock substrates, and juveniles in quiet waters over sand or mud substrates.

General Biology

In British Columbia, Nooksack Dace spawn in the spring (April through May). Spawning apparently occurs at night and the eggs are usually found near the top ends of riffles. There is no evidence of the spawning colours reported for Longnose Dace (*Rhinichthys cataractae*) in Manitoba (Bartnik 1972). Both males and females mature at the end of their second summer (1⁺) and breed in their third spring (2⁺). To date, the oldest recorded individual (a female 105 mm in standard length) was in her sixth year (5⁺). As in most fish, egg number is a function of female size, and in the Nooksack Dace fecundity ranges from about 200 to over 2000 eggs. In summer, adults feed primarily on riffle dwelling insects (e.g. nymphs of caddisflies and mayflies, dytiscid beetle larvae and adult riffle beetles). In pools the young feed primarily on chironomid pupae and ostracods. Adults collected at mid-morning have empty stomachs but packed hind guts. This suggests nocturnal feeding. In the lower Fraser Valley, adults appear to inhabit riffles throughout the year, but in less benign climates they may shift to slower, deeper water in the winter.

Limiting Factors

Habitat loss through human disturbance is the greatest threat facing the Nooksack Dace in British Columbia. Around Aldergrove, Clearbrook and Abbotsford, housing developments, shopping malls and industrial parks are replacing fields and wooded areas at a dizzying pace. This accelerating urbanization brings with it all the usual environmental problems, compounded in this case by the development being in the headwaters of the streams. Thus, both Bertrand and Fishtrap creeks and their tributaries are vulnerable to the usual fate of urban streams (e.g.,

straightening, siltation, industrial and domestic chemical spills, and clandestine garbage disposal), as well as attempts to “aesthetically improve” the streams by creating parks and ponds that please the human eye but destroy critical fish habitat. In the past, accidental fish kills in the Canadian portion of the Nooksack system would have been followed by natural recolonization from the main river. This is no longer the case. The U.S. portions of Bertrand and Fishtrap creeks are ditched and silted. They no longer contain either Nooksack Dace or habitat suitable for Nooksack Dace. Thus, the shrinking Canadian populations are sandwiched between a deteriorating environment upstream and unsuitable habitat downstream.

Special Significance of the Species

The Nooksack Dace is a member of the Chehalis fauna (McPhail 1967, 1987; McPhail and Lindsey 1986). This isolated fauna is derived from the Columbia fauna and, with the exception of the endemic Olympic Mudminnow (*Novumbra hubbsi*), all the species are closely related to Columbia species. These Chehalis isolates diverged from their Columbia counterparts sometime before the last (Fraser or Vashon) glaciation, and survived the ice-sheets south of Puget Sound but north of the Columbia River. Consequently, their geographic distributions include the Chehalis River, the rivers on the west side of the Olympic Peninsula and some rivers on the east side of Puget Sound. In two cases, the Salish Sucker and Nooksack Dace, Chehalis isolates have dispersed postglacially as far north as the lower Fraser Valley (Figure 2).

The Nooksack Dace is a typical Chehalis isolate: it is related to, and presumably derived from, the western North American form of a widely distributed species, the Longnose Dace (*Rhinichthys cataractae*). It differs from this species in scale counts (McPhail 1967; Bisson and Reimers 1977), body shape and in consistent sequence differences in both mitochondrial and nuclear genes. For example, the mitochondrial sequence differences between Nooksack and Longnose Dace are comparable to the sequence differences between such well established species as Largescale Sucker (*Catostomus macrocheilus*) and Longnose Suckers (*Catostomus catostomus*) [McPhail and Taylor, in preparation]. The Nooksack Dace also shows the characteristic distribution pattern of a Chehalis isolate: scattered populations in the Chehalis River and populations in rivers draining the west side of the Olympic Peninsula and the east side of Puget Sound (Figure 2).

Typically, the genetic separation between Chehalis isolates and their Columbia relatives, as measured by allozyme frequencies or gene sequences, is greater than their morphological separation (McPhail and Lindsey 1986; McPhail and

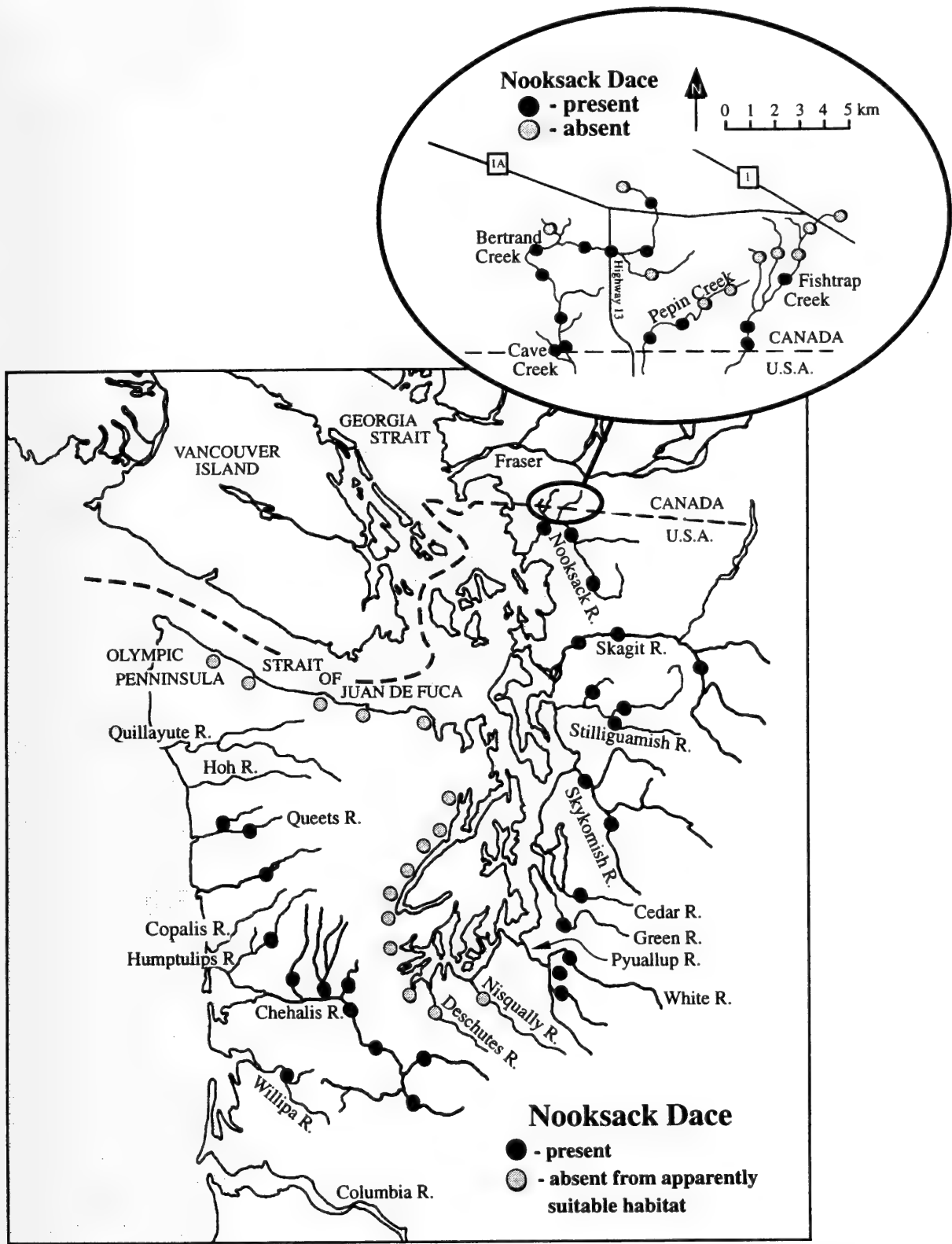


FIGURE 2. Geographic range of the Nooksack Dace, *Rhinichthys* sp. inset depicts Canadian distribution.

Taylor, in preparation). Still, Chehalis isolates usually can be separated from their Columbia counterparts by a combination of morphological traits. Because the geographic distributions of most Chehalis isolates do not overlap with their closest relatives, any decisions regarding their taxonomic status (e.g., species or subspecies) are necessarily arbitrary; however their status as independent, divergent lineages

are not debatable, and for conservation purposes they should be regarded as species. Certainly, their distinctive morphologies, gene sequences and characteristic geographic distributions argue that the Nooksack Dace has not exchanged genes with the Longnose Dace for a long time (i.e., since well before the beginning of the last glacialiation and, perhaps, since before the Pleistocene).

Evaluation

The Canadian distribution of the Nooksack Dace probably will continue to shrink as long as the Vancouver megalopolis continues to expand. To stop the decline will require a concerted effort by all levels of government to protect the remaining free-flowing streams occupied by this species ... an unlikely event. Even if the political will is there, accidents are inevitable in urban streams, especially with a drinking-water supply that for public health reasons will require chlorination in less than a decade. Once this happens, it will be a minor miracle if, in Canada, the Nooksack Dace survives into the next century.

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Status of the Northern Fur Seal, *Callorhinus ursinus*, in Canada*

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This report reviews the general biology, status, and management of the Northern Fur Seal (*Callorhinus ursinus*), with special reference to its status in Canadian waters. While Northern Fur Seals do not breed within Canadian waters, they can be found in large numbers in the waters offshore of British Columbia year-round, and occasional stragglers are found inshore. Generally found only in small groups during the pelagic phase of their life, the largest numbers occur in British Columbia waters from January through June. The eastern North Pacific population has declined significantly over the last 30 years, but the cause is unknown.

Ce rapport examine en général la biologie, le statut et la gestion de l'otarie à fourrure, (*Callorhinus ursinus*) avec référence particulière à son statut dans les eaux canadiennes. Bien que les otaries à fourrure ne se reproduisent pas dans les eaux canadiennes, on les trouve quand même toute l'année en grand nombre au large de la côte de la Colombie-Britannique et quelques errants viennent parfois dans les eaux côtières. Bien que généralement ils ne forment que de petits groupes pendant la phase pélagique de leur vie, c'est dans les eaux de la Colombie-Britannique, de janvier à juin, que l'on trouve les plus grands regroupements. La population de l'est du Pacifique nord a connu un important déclin ces trente dernières années, mais la cause est inconnue.

Key Words: Northern Fur Seal, *Callorhinus ursinus*, Otarie à fourrure, otariid, status, British Columbia.

This review of the general biology, status, and management of the Northern Fur Seal, *Callorhinus ursinus* (Linnaeus 1758), was prepared on behalf of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). A compilation and assessment of the available information on this species is used to evaluate its status in Canadian waters. For this species such a task is relatively easy in comparison to the many lesser known species of marine mammals in Canadian waters, because of the extensive investigations undertaken by U.S., Russian, and Canadian researchers.

The Northern Fur Seal, a member of the sea lion family (Otariidae), is the second smallest pinniped found on the west coast of Canada. Adult males reach a length of 1.9 m and a weight of about 200 kg, while females are much smaller, reaching a length of 1.3 m and a weight of 35 kg (Figure 1). The pelage of adults is generally a brownish-grey colour. The vibrissae colour varies with age, being black in juveniles and white in fully grown adults.

Distribution

Northern Fur Seals range throughout the northern Pacific from central Japan (latitude 36°N) and the Sea of Japan north to the Bering Sea, and south along the west coast of North America to the area of the

U.S.-Mexican border (latitude 32°N) [Figure 2]. Fur seals can be found throughout this range in almost all months of the year, but peak abundance varies seasonally and geographically. Off the Canadian west coast, females and subadult males are typically found during the winter off the continental shelf (Bigg 1990). Occasional animals are seen in inshore waters in British Columbia, and stragglers occasionally come ashore, usually at sea lion haulouts (e.g., Race Rocks, off southern Vancouver Island).

Three breeding colonies occur in Russia; at Robben (Tyuleniy) Island and the central Kuril Islands in the Sea of Okhotsk, and Commander Island in the western Bering Sea. In the United States, colonies occur at the Pribilof Islands (St. George and St. Paul islands) in the eastern Bering Sea, at Bogoslof Island in the southeast Bering Sea, and at San Miguel Island and nearby Castle Rock off southern California. Reeves et al. (1992) noted that a few fur seals also haul out seasonally on Southeast Farallon Island and occasionally on San Nicolas Island, off California.

Protection

International

The Interim Convention on Conservation of North Pacific Fur Seals lapsed in 1984, when the United

*Reviewed and approved by COSEWIC 16 April 1996 —status assigned: Not at Risk (NAR).

States Senate failed to ratify a protocol for extension. This international agreement protected the fur seal from hunting at sea, but also allowed for the commercial harvest of fur seals in the Pribilof Islands. Attempts to establish a new treaty for the protection of the fur seal have failed; consequently the species is vulnerable to future hunting of animals at sea. Under the terms of this agreement Canada received 15 percent of the skins from harvests, and was also obliged to undertake research on this species.

The Northern Fur Seal is not listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), thus international trade is not monitored or regulated.

National

Canada: In Canada the Northern Fur Seal is protected under the 1993 Marine Mammal Regulations of the Fisheries Act of Canada. These regulations control the hunting of this species in Canadian waters by all except aboriginals, who are required to obtain a licence. Fees for such a licence are low (\$5), and issuance is at the discretion of the Minister of Fisheries and Oceans. "Disturbance" is prohibited through these regulations, except when hunting under licence, as is the operation of aircraft within 600 m of any live seal on land.

United States: After the international convention lapsed in 1984, management of this species in U.S. waters became subject to the Fur Seal Act of 1966 and the Marine Mammal Protection Act of 1972. The commercial harvest on the Pribilof Islands ended because the National Marine Fisheries Service (NMFS) determined that such a harvest could not take place under domestic laws. Current levels and conditions for a subsistence harvest are regulated under these Acts. In 1988 the U.S. population was listed as depleted under the Marine Mammal Protection Act. Under this Act, a conservation plan was prepared for this species (National Marine Fisheries Service 1993), outlining protective measures and research activities to be undertaken by the U.S. National Marine Fisheries Service.

Population Size(s) and Trends

Several stocks have been generally recognized for the Northern Fur Seal; however, tag returns suggest that some exchange occurs between breeding colonies. The Pribilof Islands population is the largest, comprising three quarters of the world's total, with just less than one million individuals in the early 1990s (National Marine Mammal Laboratory, unpublished data). This population was thought to number between two to three million individuals in the mid-1800s (National Marine Fisheries Service 1993), and was estimated at approximately 2.1 million individuals in the 1940s (Kenyon et al. 1954; Lander and Kajimura 1982; Briggs and Fowler 1984). Based on pup counts, the population

on St. Paul Island (representing about 80% of the Pribilof stock) has remained relatively stable since the early 1980s, while the St. George stock has undergone a significant decline since the late 1970s (York and Fowler 1992). The Pribilof Island population(s) appear to be well below the level of maximum net productivity (Ragen 1995). Northern Fur Seals first began breeding at Bogoslof Island in the southeast Bering Sea in 1980, and the population in 1988 comprised over 400 individuals, increasing at a rate of 57% per year (Loughlin and Miller 1989). Fur seals also began breeding at San Miguel Island (California) in 1968 and at nearby Castle Rock in 1972. The San Miguel colony numbered approximately 5000 individuals by 1993 and was increasing (DeLong et al. 1993).

Habitat

Terrestrial habitats for Northern Fur Seals are generally limited to their rookeries, which are scattered around the North Pacific rim in close proximity to the continental slope. Fur seals have strong fidelity to traditional sites that are typically composed of a rocky substrate (on San Miguel Island they use a sand beach). Although all rookeries in the U.S. are federally owned, the Pribilof Islands are inhabited and non-rookery lands are owned by local communities which are developing support facilities for fishing industries. Consequently, several types of habitat degradation are possible.

Ocean habitats appear to vary by the sex and age group(s) of fur seals present. In the summer breeding season, continental slope waters in the eastern Bering Sea are the principal destination for adult females on foraging trips. The use of continental shelf and slope waters of British Columbia and the states of Washington, Oregon, and California by adult females during winter is well documented from pelagic sealing data (Bigg 1990). Adult males from the Alaskan populations appear to remain in Alaskan waters year-round, some remaining in the Bering Sea and some moving south into the Gulf of Alaska in mid-winter. Subadults of both sexes use coastal waters of British Columbia and Washington as well as offshore areas of the North Pacific (Kajimura 1984; Bigg 1990). The highest concentrations in the open ocean occur along the continental shelf break and in association with other major oceanographic frontal features, such as canyons, sea mounts and valleys (Kajimura 1984). Although water quality in these areas is unknown, it appears to be suitable with the exception of areas subjected to oil spills. Trends in the availability of prey in these areas are unknown.

General Biology

Reproduction

Female Northern Fur Seals may produce their first pup at four years of age, and the majority are pupping by six years of age (York and Hartley 1981). A



FIGURE 1. Northern Fur Seals. Photo by O.W. Otsen. The small animal at left is an adult female, the large animal is an adult male.

single pup is born within two days of the arrival of a female at the breeding colony. Parturition appears to be stimulated by arrival at the breeding colony and the presence of conspecifics (Bigg 1984). For the first 8-10 days after birth, females remain ashore until they come into estrous and mate. After that time they regularly leave the colony for foraging trips of 4-10 days. Insley (1992) demonstrated that calls used between mother-offspring pairs of Northern Fur Seals were highly variable between individuals, but varied little for a particular individual, allowing the mother and pup to reunite after separating. Pups remain on the breeding islands until they are weaned in late fall. Pup weight depends in part on that of the mother and on sex, male pups are larger at birth (Boltnev 1993). Adult males remain ashore and fast while defending breeding territories. Juvenile males also haul out during the breeding season and fast, typically losing about 20% of their body mass during this time (Baker et al. 1993).

Diet

Knowledge of the diet of the Northern Fur Seals comes primarily from the examination of stomach contents of animals killed as part of a joint U.S.-Canadian research program from 1958 to 1974

(Kajimura 1984; Perez and Bigg 1986), and in part from scat analysis (Antonelis et al. 1990, 1993). Primary prey species vary seasonally (Perez and Bigg 1986). Differences in diet also occur throughout their range, both on a large (Perez and Bigg 1986) and small scale (Antonelis et al. 1993). Small schooling fishes are the primary food species in terms of energy content. In British Columbia waters, Pacific Herring (*Clupea harengus*) and various species of squid comprise about 70% of the diet. Walleye pollock, sablefish, rockfishes, whiting, and salmonids form the remainder of the diet (Perez and Bigg 1986). Historical evidence suggests that the composition of the diet has fluctuated over time with changes in fish stocks; sardines were once extremely abundant in the eastern North Pacific but were overfished in the 1940s until the stocks collapsed. There is some evidence that sardines were commonly eaten by Northern Fur Seals off Vancouver Island in the early 1930s (Clemens and Wilby 1933).

Movements

In general, Pribilof Island fur seals migrate south to winter along the west coast of Canada and the United States. However, patterns of movement of this species are extensive and complex, with timing

and migratory routes depending on age, sex and reproductive condition (Bigg 1990). Bigg (1990) suggested that fur seal migration from the Bering Sea after the breeding season facilitated both the avoidance of low temperatures and access to sources of prey. He also suggested that the age-related differences in migratory timing and routes likely results from a combination of the learning of productive foraging areas and the need to return to the breeding areas when animals reach reproductive age. The origin of sex-related differences in migration may result in part from differences in the timing of arrival to and departure from the breeding colonies. Adult females both arrive at and leave colonies later than adult males. Males start to arrive at colonies in May to establish territories and females start arriving in mid-June. Males depart in late summer while females remain until late fall while they continue to nurse their young. The fall movements of pups away from the rookeries is not random; estimated minimum swimming speed of pups between St. Paul Island and the Aleutians was between 36 to 61 km/day (Ragen et al. 1993). Fowler et al. (1993) demonstrated that male Northern Fur Seals generally return to their natal rookery, although individuals sometimes emigrate to other rookeries or, rarely, form new colonies.

Short-distance movements around San Miguel Island by females nursing pups were examined by Antonelis et al. (1990), who found that females foraged primarily in oceanic waters over the continental slope. These females departed the colony in greatest numbers in mid-day, possibly a thermoregulatory behaviour in response to increasing temperatures and solar radiation.

Behaviour

Northern Fur Seals generally exhibit strong site fidelity to their rookeries. Despite disturbance associated with commercial harvesting by human inhabitants on the Pribilof Islands from the late 1700s until recently, seals continue to occupy nearly all the same rookeries. This species appears to be tolerant to short term disturbance associated with human activities (Gentry and Gilman 1990). The proximity of these islands to the continental slope likely contributes to their continued use of these rookeries.

Limiting Factors

Commercial harvesting has affected the population of Northern Fur Seals in the Pribilof Islands since shortly after it was first discovered in 1786 (National Marine Fisheries Service 1993). From 1786 to 1828 an average of a hundred thousand Northern Fur Seals per year, primarily pups, were killed. Commercial harvesting of this species was directly responsible for the large reductions in population size in the late 1800s and early 1900s. The commercial harvest during this early period included pregnant females; dur-

ing the period of pelagic sealing, large numbers of animals were taken off British Columbia and in the Bering Sea (National Marine Fisheries Service 1993). Hunts were reduced in size in the early 1900s, and the population grew up to the 1940s. Approximately 300 000 females were killed between 1956 and 1968, in an effort to move the population towards the level where productivity would be maximized. The population did not respond as expected however, and pup production decreased (York and Hartley 1981). When the commercial harvest of females ceased in 1968, pup production increased and the population grew until 1976. While hunting continued during this period, it is considered unlikely to be the cause of a decline in the population size after 1976 (National Marine Fisheries Service 1993). Commercial harvests continued for this species up until the expiration of the Interim Convention on Conservation of North Pacific Fur Seals in 1984. Since that time, between about 1200 and 3700 juvenile males have been killed each year as part of a subsistence harvest. Such levels are not thought to contribute to the lack of recovery of the population (National Marine Fisheries Service 1993).

A variety of other natural and anthropogenic sources of mortality for this species have been observed. Several authors have examined causes and levels of mortality in pups, both at breeding colonies and during the winter. Calambokidis and Gentry (1985) observed that pup survival from birth to weaning was positively correlated with birth weight, which in turn was correlated with the age of the mother. Pups which weighed less than average were more likely to die from trauma, parasitic infestation and infectious disease, as well as "emaciation syndrome". Baker and Fowler (1992) examined pup weight and overwintering survival, and found that the overwintering survival of males increased with pup weight. Their small female sample size likely precluded a similar determination (Baker and Fowler 1992). They suggested that larger overwintering animals were better able to withstand cold temperatures. Larger animals are also able to dive longer (Kooyman 1989 in Baker and Fowler 1992), possibly increasing the ability to find prey. Predation by sharks, foxes, Killer Whales (*Orcinus orca*) and Steller Sea Lions (*Eumetopias jubatus*) has been recorded (Bychkov 1967; Gentry and Johnson 1980; Hanna 1922; Reeves et al. 1992; National Marine Fisheries Service 1993). Three to seven percent of fur seal neonates on St. George Island were killed by sea lions in 1974 and 1975 (Gentry and Johnson 1980); no data on mortality levels from Killer Whales or sharks are available.

Natural environmental fluctuations, such as the periodic occurrence of El Niño, has negatively affected the population breeding at San Miguel Island, although conditions for the Pribilof Island

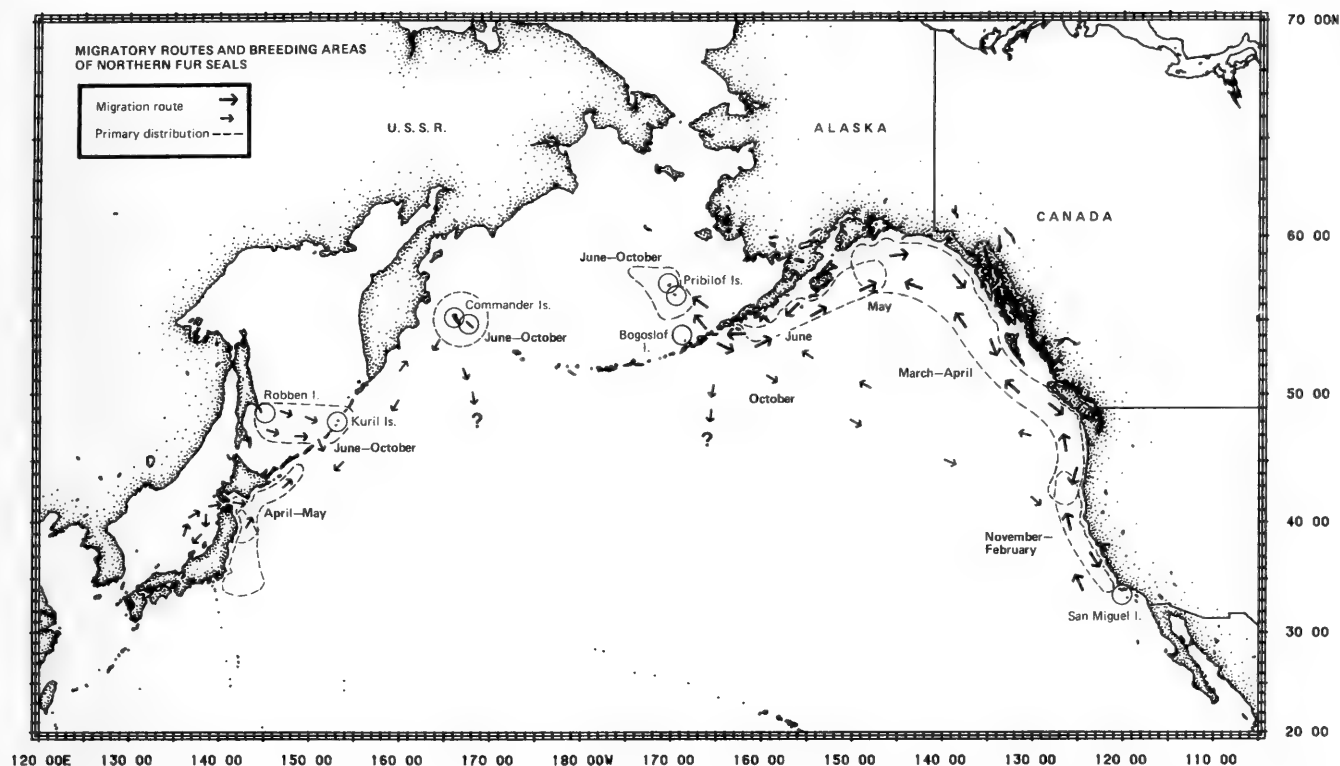


FIGURE 2. Distribution of the Northern Fur Seal off the west coast of North America. Breeding islands are located in the circles. Reproduced from Loughlin and Miller (1989) by permission.

population may be enhanced by increased sea surface temperatures associated with these events (York 1991). The 1983 El Niño occurred just prior to implantation of embryos at San Miguel Island, and resulted in an increase in pup mortality and a decrease in pup weights. DeLong et al. (1993) suggested that the later onset of the 1992 El Niño affected this population less intensely. Competition with fisheries has been suggested as a possible limiting factor for this species, both in waters surrounding breeding colonies, along migration routes, and during the non-breeding season in the North Pacific. The interactions between commercial harvesting of prey species and fur seal movements, reproductive rates or mortality is unclear, however (National Marine Fisheries Service 1993).

Calambokidis and Peard (1982) examined levels of chlorinated hydrocarbons from Northern Fur Seals in Alaska, but found concentrations well below levels thought to contribute to reproductive problems in other populations of pinnipeds. Anas (1974) reported levels of heavy metals in fur seals from Alaska and Washington State, but no information is available on potential impacts. An analysis of heavy metals by Noda et al. (1995) revealed higher cadmium concentrations in northern fur seals than in other otariids. Cadmium levels were higher, and mercury levels lower, than those reported by Anas (1974); however, heavy metal concentrations in Northern Fur Seals are variable with age, location, and probably season, making comparisons between studies difficult (Noda

et al. 1995). Entanglement in fishing gear is probably a more significant problem. Northern Fur Seals were the third most commonly caught species of marine mammal recorded in an observer program of the Japanese driftnet fishery for squid in 1989 (Anonymous 1990). Two animals were killed in an experiment drift gillnet fishery for Neon Flying Squid (*Ommastrephes bartrami*) in Canadian waters in the mid-1980s (Jamieson and Heritage 1988). Entanglement in marine debris is also a source of mortality. Fowler (1987) suggested that mortality due to entanglement in marine debris has contributed significantly to the decline in the population on the Pribilof Islands. Recent declines have also occurred in the numbers of Steller Sea Lions (Loughlin et al. 1992) and Harbour Seals, *Phoca vitulina* (Pitcher 1990) in the central and eastern Gulf of Alaska. While many possible causes have been identified (reviewed above), the exact causes of these declines continues to remain unclear.

Special Significance of the Species

This species is the only fur seal found in the temperate waters of the north Pacific Ocean and is endemic to this region. Alaskan natives on the Pribilof Islands harvest approximately 2000 subadult males annually for food.

Evaluation

The present world population of Northern Fur Seals is substantially lower than historical levels,

and causes of the decline are unclear. Although the market demand for furs is currently low, the lack of any international regulatory body or agreement on the management of the species means that killing of this species at sea could be undertaken at any time, and trade is not restricted or monitored through any international agency. Rapid development of fishing industry support services on the Pribilof Islands has the potential to adversely affect this population.

Acknowledgments

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Status of the Lacs des Loups Marins Harbour Seal, *Phoca vitulina mellonae*, in Canada*

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The Lacs des Loups Marins Harbour Seal (*Phoca vitulina mellonae*) is a subspecies that occurs in the area of Lacs des Loups Marins (Lower Seal Lakes) (56°N, 73–74°W), 160 km east of Hudson Bay, on the Ungava peninsula of northern Québec. With the possible exception of Lake Iliamna, Alaska, it is the only known Harbour Seal population that is resident in freshwater year-round. Written references to the unique appearance and behaviour of this seal date back to 1818. The subspecies was described primarily on the basis of its unique morphology and presumed long-time geographic isolation from neighbouring oceanic Harbour Seals. Estimates of the population's size are imprecise, and range from 100 to 600 animals. Little is known of the seals' habitat requirements other than that they seem to feed exclusively in freshwater, and are likely reliant on some specific environmental features such as under-ice air pockets to sustain them through the winter. Pupping seems to take place substantially earlier (mid-April to mid-May) than in other Harbour Seal populations at similar latitudes. The only known cause of human-induced mortality is occasional hunting by aboriginal peoples. *Phoca vitulina mellonae* is potentially vulnerable because of its small population size, restricted range, and susceptibility to disturbance.

Les phoques communs des Lacs des Loups Marins (*Phoca vitulina mellonae*) sont une sous-espèce que l'on trouve dans la région des Lacs des Loups Marins (Lower Seal Lakes) environ au 56–57°N, 73–74°O à 160 km à l'est de la Baie d'Hudson, sur la péninsule d'Ungava, au nord du Québec. À l'exception, peut-être, du Lac Iliamna en Alaska, c'est la seule population de phoques communs connue qui reste dans les eaux douces toute l'année. On dispose de références écrites sur l'apparence et le comportement uniques de ce phoque depuis 1818, et on a d'abord décrit cette sous-espèce à partir de sa morphologie particulière et selon l'hypothèse qu'elle est depuis longtemps géographiquement isolée des phoques communs océaniques avoisinants. Les estimations de leur population sont peu précises et donnent entre 100 et 600 individus. On en connaît peu sur les exigences des phoques quant à leur habitat à part le fait qu'ils semblent dépendre de certaines caractéristiques environnementales précises comme des poches d'air sous la glace pour qu'ils puissent passer l'hiver. La naissance de petits semble subvenir sensiblement plus tôt dans leur cas (mi-avril à mi-mai) que dans celui d'autres phoques à des latitudes comparables. Les seules causes de mortalité connues sont quelques références, à des prises de chasse par des Autochtones. Sa petite population, son aire restreinte et sa vulnérabilité aux dérangements justifient qu'on accorde à cette espèce un statut de vulnérable.

Key Words: Harbour Seal, *Phoca vitulina*, Phocidae, pinniped, freshwater seals, phoque commun, Lacs des Loups Marins, northern Québec, endangered species.

The Lacs des Loups Marins Harbour Seal, *Phoca vitulina mellonae* (Doutt 1942) [Figure 1], is confined to the area of Lacs des Loups Marins (Lower Seal Lakes), approximately 160 km east of Hudson Bay, on the Ungava peninsula of northern Québec (Figure 2) [Doutt 1942; Anderson 1946; Scheffer 1958; Bigg 1981].

While there are numerous references to Harbour Seals occurring in freshwater worldwide (Erlandson 1834; DeKay 1842; Allen 1880; Browne 1909; Grenfell 1910; Prichard 1911; Strong 1930; Dunbar 1949; Fisher 1952; Wheeler 1953; Harper 1956, 1961; Beck et al. 1970; Paulbitski 1974; Roffe and Mate 1984; Williamson 1988), *Phoca vitulina mellonae* is the only known Harbour Seal population resident in freshwater year-round (Atkinson 1818; Clouston 1820; Hendry 1828; Finlayson 1830; Low 1898; Lewis 1904; Flaherty 1918; Twomey 1938;

Doutt 1942; Manning 1946; Doutt 1954; Graburn 1969; Power and Gregoire 1978; Smith and Horonowitsch 1987; Consortium Gilles Shooner & Associés et al. 1991). A freshwater population is found in Lake Iliamna, Alaska, but it is the Pacific subspecies *Phoca vitulina richardsi*, and it is not certain whether it is landlocked (Everitt and Braham 1980).

Written references to the unique appearance and behaviour of *Phoca vitulina mellonae* date back to Atkinson (1818). The subspecies was described primarily on the basis of an unusually dark pelage and an enlarged coronoid process on the mandible (Doutt 1942), with the presumption that the population had been isolated for 3000 to 8000 years, trapped by the Ungava peninsula's isostatic rebound since the retreat of the Laurentian ice sheet. Other authors disputed this interpretation, however, arguing that the

*Reviewed and approved by COSEWIC 16 April 1996 —status assigned: Vulnerable.



FIGURE 1. One of the specimens of Lacs des Loups Marins Harbour Seal that were collected in March 1938, by the Carnegie Museum of Natural History. The animal has just been shot by Daniel Petagumskum, one of the expedition's Cree guides (photograph by J. K. Douth; reproduced with the permission of the Carnegie Museum of Natural History, Pittsburgh, Pennsylvania).

supposed morphological anomalies of *Phoca vitulina mellonae* are merely artifacts of a small sample size, and that the seals are likely able to travel freely between salt and freshwater (Mansfield and McLaren 1958; Mansfield 1967; Smith and Horonowitsch 1987; *also see* Honacki et al. 1982; King 1983; Wiig 1989; Reeves et al. 1992). Other work, the majority of it recent, strongly supports the validity of a subspecific designation for *Phoca vitulina mellonae* (Davies 1958; Consortium Gilles Shooner & Associés et al. 1991; Smith et al. 1994; 1996; Smith 1996).

Distribution

This is clearly a population with restricted distribution (Figure 2). There are historical references to the presence of this seal in Lac Minto, at the head of Rivière aux Feuilles (Flaherty 1918; Manning 1947), Lac Beneta, situated in the basin of Rivière aux Mélézes (Manning 1947), Petit Lac des Loups Marins (Atkinson 1818; Clouston 1820; Douth 1942), and Lacs des Loups Marins (Hendry 1828; Finlayson 1830; Low 1898; Lewis 1904; Douth 1942; Douth 1954; Power and Gregoire 1978; Berrouard 1984; Smith and Horonowitsch 1987). Several sightings have been made by Hydro-Québec employees and contractors in the

Rivière aux Feuilles, Lac Melvin and Rivière Delay (Consortium Gilles Shooner & Associés et al. 1991). Inuit hunters, interviewed by Hydro-Québec contractors, reported seeing or killing freshwater seals in Lac Guillaume-Delisle, Rivière Nastapoca, Rivière Boniface, Rivière Niagurnaq, Rivière Kuunga, Rivière Longland, Lac Tasialuk, and Lacs des Loups Marins (Archéotec Inc. 1990). The Cree nation of Whapmagoostui considers the range of *Phoca vitulina mellonae* to be Lacs des Loups Marins, Petit Lac des Loups Marins, and Lac Bourdel, with some reports of animals having once been in Lac à l'Eau Claire (Clearwater Lake) (J. Petagumskum Sr., Whapmagoostui, Québec, personal communication).

Hydro-Québec has recently compiled observations made of these freshwater seals between 1970 and 1990 (Consortium Gilles Shooner & Associés et al. 1991). Though their survey efforts have been concentrated largely in Lacs des Loups Marins, Hydro-Québec's data nevertheless indicate the presence of seals in Rivière Nastapoca, Lacs des Loups Marins, Petit Lac des Loups Marins, Lac Bourdel, Lac à l'Eau Claire, and Petite Rivière de la Baleine. In addition, evidence from recordings of underwater vocalizations suggests the presence of seals in Rivière aux Feuilles, Rivière aux Mélézes,

Rivière du Gué, Grande Rivière de la Baleine and La Grande Rivière (Consortium Gilles Shooner & Associés et al. 1991).

During the autumn of 1995, four seals were captured in Lacs des Loups Marins and affixed with satellite-linked time-depth recorders (Wildlife Computers, Redmond, Washington). All four tags transmitted from early September to mid-November, and during that time all four seals remained within Lacs des Loups Marins or in the immediate vicinity (R. J. Smith, unpublished data).

Protection

Because Canada possesses no specific marine mammal or endangered species legislation, and because it is unclear whether *Phoca vitulina mellonae*, a marine mammal in freshwater, falls within a provincial or federal jurisdiction, the population currently has minimal legal protection. Freshwater seals north of the 55th parallel are listed as a protected species under the James Bay and Northern Québec Agreement (Québec 1976); however, this protection does not have the force of law (J. Gunn, Ministère de l'Environnement et de la Faune, Radisson, Québec, personal communication). *Phoca vitulina mellonae* was recently listed by the International Union for the Conservation of Nature and Natural Resources (IUCN) as being "insufficiently known", meaning that it is "suspected but not definitely known to be endangered, vulnerable, or rare due to a lack of reliable information" (Reijnders et al. 1993). The government of Québec has listed the population as "likely to be designated as threatened or vulnerable" (Québec 1992a), and is considering whether to give legal protection to a portion of *Phoca vitulina mellonae*'s habitat (Dubreuil 1983; Québec 1992b). This protection should be a priority given that the proposed Grande Baleine hydroelectric development could have an adverse impact on a large portion of this population's range (Rosenthal and Beyea 1989; Rougerie 1990; Woodley et al. 1992; Smith et al. 1994).

Population Size And Trends

Estimates of the size of this small population are imprecise. A maximum of 500 animals was the "guess" of Doult (1957), cited in Scheffer (1958). Power and Gregoire (1978) estimated 200 and 600 animals by two different summations. The most recent estimate by Consortium Gilles Shooner & Associés et al. (1991) was approximately 100 animals, or 0.1 seals/km², in Lacs des Loups Marins and Lac Bourdel. Population trends over time obviously cannot be calculated.

Habitat

Little is known of the habitat and ecological requirements of this subspecies. The few dead ani-

mals that have been examined were found to have salmonid (*Salvelinus* sp.) otoliths in their stomachs (Consortium Gilles Shooner & Associés et al. 1991; Smith et al. 1996). Comparisons of the stable-isotope ratios and fatty acid profiles of the tissues of *Phoca vitulina mellonae* and Harbour Seals collected from oceanic locations indicate that, over a two year period, *Phoca vitulina mellonae* seemed to be feeding exclusively in freshwater (Smith et al. 1996).

Recent investigations found no permanent haulout sites on Lacs des Loups Marins and Lac Bourdel (Consortium Gilles Shooner & Associés et al. 1991). In winter, when the vast majority of the lakes and rivers are covered in ice, the seals may rely on several physical features for their sources of air: areas that remain ice-free because of strong currents, fissures in the ice, and air pockets created by the shoreline's complicated geometry or by the undulations in the bottom of the sheet ice on the lake's surface (Smith and Horonowitsch 1987; Consortium Gilles Shooner & Associés et al. 1991; Dean Consulting & Research Associates Inc. 1991).

None of the habitat of this population is protected. It is entirely on Crown land that could be adversely affected by Hydro-Québec's construction of the proposed Grande Baleine hydroelectric project (Woodley et al. 1992) which, though indefinitely postponed by the current provincial government, has not been cancelled altogether. One of the results of the Grande Baleine environmental assessment process has been that Hydro-Québec is now required to evaluate properly the likely impacts of the project on the population, prior to construction (Review Bodies 1994). Some of these potential impacts include the disappearance of ice-free areas and under-ice shoreline shelters, upon which the seals may rely in the winter, in water courses with altered flows arising from hydroelectric development. The Grande Baleine project may also affect the distribution and abundance of the seals' prey, and contaminate the animals with methyl mercury released from the flooded, decomposing vegetation (Woodley et al. 1992). The negative effects of this habitat destruction could lead to a decline in the seal population and an impoverishment of its genetic diversity (Alfonso and McAllister 1994).

General Biology

Reproduction probably occurs between mid-April and mid-May in the Lacs des Loups Marins area; substantially earlier than other Harbour Seal populations at a similar latitude (Doult 1942; Archéotec inc. 1990; Consortium Gilles Shooner & Associés et al. 1991; Temte et al. 1991; Smith et al. 1994). Since the lakes are still iced over at the time of pupping, and no births have been observed on the ice, several authors have postulated that pupping takes place in under-ice shelters (Consortium

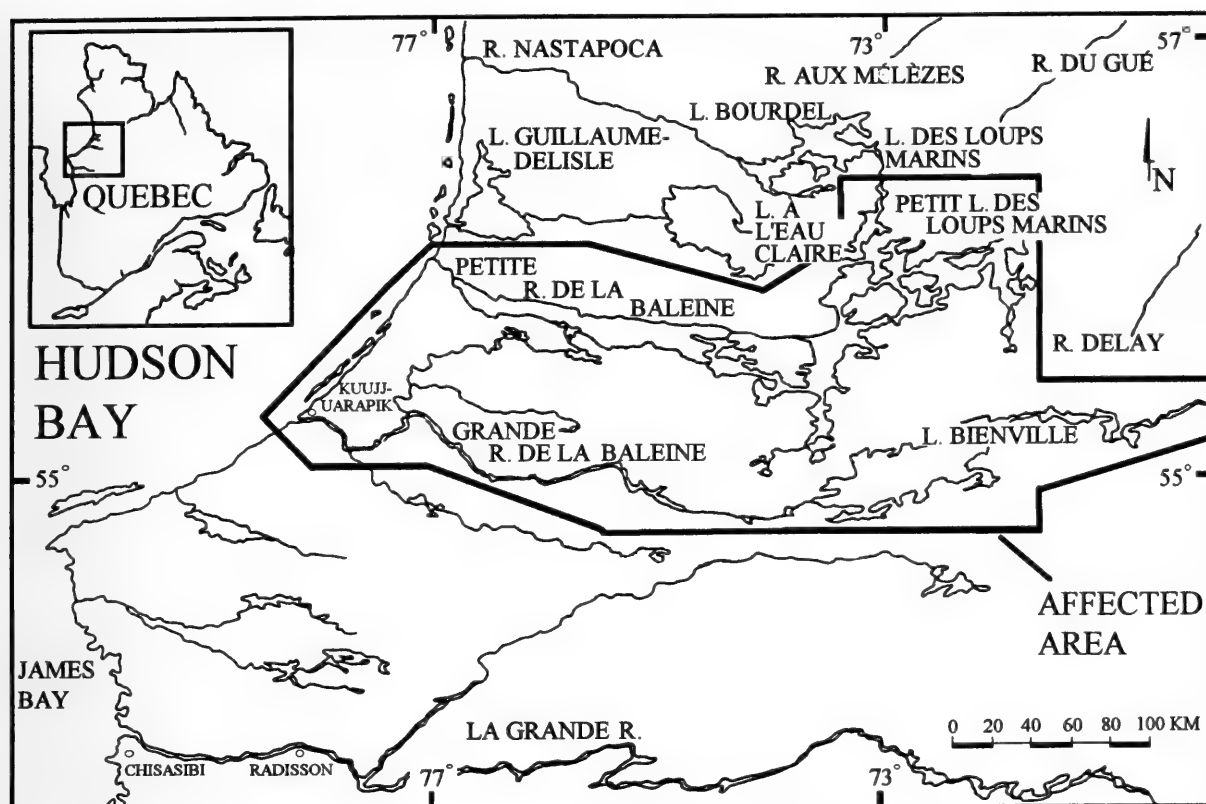


FIGURE 2. Known range of *Phoca vitulina mellonae* in relation to Hydro-Québec's proposed Grande Baleine hydroelectric project.

Gilles Shooner & Associés et al. 1991), like those of Ringed Seals (*Phoca hispida*) (Smith and Stirling 1975).

The only known cause of human-induced mortality is occasional hunting of the seals by aboriginal peoples (Clouston 1820; Low 1898; Flaherty 1918; Douth 1942; Douth 1954; Consortium Gilles Shooner & Associés et al. 1991; J. Petagumskum Sr., personal communication).

Seasonal movements of the population are poorly known, though the sporadic observations of Gilles Shooner & Associés et al. (1991) hint at seals spending the winter months in larger bodies of water like Lacs des Loups Marins, Lac Bourdel, and Petit Lac des Loups Marins, with some dispersal into outlying, smaller bodies of water upon the melting of the ice. These investigators report finding many worn trails between bodies of water frequented by the seals, some as long as 0.15 km, and on inclines as steep as 25°. There is no evidence that animals move between the area of Lacs des Loups Marins and Hudson or Ungava Bays. However, though there are a number of impassable waterfalls on the Rivière Nastapoca, some authors believe that if the seals could move into the more placid rivers that flow north into Ungava Bay, this would be a feasible avenue of exchange between the fresh and saltwater populations (Mansfield 1967; SOGEAM 1985; Smith and Horonowitsch 1987).

Preliminary evidence from DNA sequencing of region I of the mitochondrial D-loop indicate that *Phoca vitulina mellonae* has haplotypes that are unique when compared to Harbour Seals in the eastern Canadian arctic and Northwest Atlantic (Smith 1996).

Animals hauled out in the spring months are usually in small groups, whereas at the end of the summer, they are usually hauled out singly or in pairs. It has been suggested that this behaviour is related to the moulting process (Consortium Gilles Shooner & Associés et al. 1991).

Limiting Factors

The tendency of Harbour Seals to be distributed in small local populations makes them vulnerable to disturbance (Maine Seal 1994). There are a number of examples of local Harbour Seal populations being extirpated, or their numbers drastically reduced, by human activity. For example, a small population that seemed to frequent Lake Ontario was eliminated by the early 1800s (DeKay 1842; Allen 1880); the population in Greenland is practically extirpated (Teilmann and Dietz 1993; R. Dietz, personal communication), an important reason being the intensity with which it has been hunted and entangled in fishing gear; the population in Hokkaido, Japan, is very small, with removals from incidental catches in fishing gear

exceeding recruitment (Reijnders et al. 1993). Given such evidence, the Lacs des Loups Marins seal population is likely sensitive even to limited disturbance by humans.

Special Significance of the Subspecies

This population of Harbour Seals is unique, in that it is the object of reverence by the aboriginal peoples of northern Québec (Archéotec Inc. 1990; Richardson 1991; Posluns 1993; M. George, Whapmagoostui, Québec, personal communication); it is the object of a wealth of historical references, and seems to be unusual in a number of ways, including aspects of its biology (Consortium Gilles Shooner & Associés et al. 1991; Smith et al. 1994, 1996; Smith 1996). The population has also acquired something of a public profile over the last few years (e.g.: Dubreuil 1987).

Evaluation

It is essential for the future viability of this subspecies that the potential impacts on the population from the Grande Baleine hydroelectric project, and any other future development in Québec's north, be eliminated or seriously mitigated. Because of the inaccessibility of the population, there is no known trade in the subspecies, legal or otherwise.

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Updated Status of the Sea Otter, *Enhydra lutris*, in Canada*

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Sea Otters (*Enhydra lutris*) ranged historically across the north Pacific from the central Pacific coast of Baja California, to northern Japan. An intensive fur hunt in the 18th and 19th centuries extirpated the Sea Otter from much of its range. The species was protected in 1911, and now occupies approximately half of its historic range. Presently, the worldwide population of Sea Otters is thought to be about 150 000 animals. The British Columbia Sea Otter population, originating from 89 animals reintroduced to Vancouver Island from 1969 to 1972, has increased at a finite rate of 18.6% per year, a rate similar to reintroduced populations in Washington and southeast Alaska. In 1995, a minimum of 1522 Sea Otters were found in British Columbia. Most of these animals occurred off Vancouver Island, but at least 135 Sea Otters were found near Goose Island, 125 km north of Vancouver Island. The origin of this latter group is uncertain. Sea Otters are presently classed as threatened in British Columbia and are protected under Federal and Provincial regulations.

À une certaine époque, les loutres de mer, *Enhydra lutris*, étaient repandues partout dans le Pacifique nord, de la côte Pacifique centrale de Baja, en Californie, jusqu'au nord du Japon. Aux 18^e et 19^e siècles, une chasse intensive à la fourrure a fait disparaître la loutre d'une grande partie de son aire de répartition. On commença à protéger l'espèce en 1911 et elle est maintenant revenue dans près de la moitié de son aire historique. On croit que la population mondiale de la loutre s'élève présentement à quelques 150 000 individus. La population de loutres de mer de la Colombie-Britannique, commencée avec 89 animaux réintroduits à la île de Vancouver de 1969 à 1972, a augmentée à un taux de croissance fixe de 18,6 % par année, un taux semblable à celui des populations réintroduites dans l'état de Washington et dans le sud-est de l'Alaska. En 1995, un minimum de 1522 loutres de mer ont été relevées en Colombie-Britannique. La plupart de ces animaux ont été vus au large de l'île de Vancouver, mais on en a trouvé au moins 135 près de Goose Island à 125 km au nord de l'île de Vancouver. On n'est pas certain de l'origine de ce dernier groupe. Les loutres de mer ont présentement le statut d'espèce menacé en Colombie-Britannique et elles sont protégées en vertu de règlements fédéraux et provinciaux.

Key Words: Sea Otter, Loutre de mer, *Enhydra lutris*, otters, keystone predator, mustelid, fur trade.

The Sea Otter, *Enhydra lutris* (Linnaeus, 1758), is one of the largest members of the family Mustelidae, but the smallest of marine mammals (Estes 1980). An adult male Sea Otter (Figure 1) may weigh up to 45 kg and attain a length of about 1.4 m; females are smaller (Kenyon 1969; Estes 1980). In contrast to other marine mammals, which rely upon blubber for insulation, Sea Otters depend upon their dense fur for protection against chilly ocean water (Kenyon 1969). The coat is light to dark brown in colour, often becoming grizzled with age, especially around the head (Kenyon 1969; Garshelis 1984). Sea Otters have a high metabolic rate consuming up to one quarter of their body weight in food each day (Riedman and Estes 1990). Sea Otters feed on benthic invertebrates, often limiting the abundance of their prey, which has wide-ranging ecological consequences on community structure (Estes et al. 1989). Previous COSEWIC (Committee on the Status of Endangered Species of Wildlife in Canada) reports on the Sea Otter population in Canada were published by Monroe (1985) and MacAskie (1987).

Distribution

Sea Otters ranged historically across the Pacific rim, from northern Japan to central Baja California (Figure 2) [Kenyon 1969; Riedman and Estes 1990]. An intensive fur hunt for Sea Otters, commencing in the 1740s resulted in their near extinction (Kenyon 1969). Sea Otters were protected in 1911, when less than 2000, animals in 13 relic groups, remained (Figure 2) [Kenyon 1969].

Several of these remnant groups declined to extinction, likely because of their small size. One such group located off the Queen Charlotte Islands, disappeared, and the last Sea Otter known to inhabit British Columbian (Canadian) waters was shot in 1929 off Vancouver Island (Cowan and Guiguet 1960; Kenyon 1969; Monroe 1985).

The Sea Otter currently occupies approximately half of its historical range (Figure 2), extending from the northern Gulf of Alaska, westward through the Aleutian archipelago to the Kamchatka Peninsula and the Kuril archipelago (Estes 1990a). Large areas to the south of the Gulf of Alaska

*Reviewed and approved by COSEWIC 16 April 1996, status assigned: Threatened (downlisted from Endangered).

remain uninhabited, except for recently reintroduced populations in southeast Alaska, British Columbia, Washington, and a remnant population in California.

During the 1960s and early 1970s, Sea Otters captured at Amchitka Island and Prince William Sound were reintroduced to unoccupied habitat in Alaska, British Columbia, Washington, and Oregon (Riedman and Estes 1990; Estes 1990b). Eighty-nine Sea Otters were reintroduced to Checleset Bay off northwest Vancouver Island; 29 in 1969, 14 in 1970, and 46 in 1972. By 1972, Sea Otters had been sighted from the Queen Charlotte Islands to Barkley Sound, suggesting that some of the translocated animals had dispersed (Bigg and MacAskie 1978). In 1977, aerial surveys found Sea Otters near the original transplant site in Checleset Bay, and off Bajo Reef, Nootka Island, 75 km to the southeast (Figure 3) [Bigg and MacAskie 1978]. Until 1991, the Vancouver Island Sea Otter population was composed of two groups, one in Checleset Bay and a second off Nootka Island (MacAskie 1987), but by 1992 the population ranged continuously from Estevan Point northwest to Quatsino Sound (Figure 3) [Watson 1993]. Between 1977 and 1991 the range of the Vancouver Island Sea Otter population expanded at a rate of 15.3% per year (Watson 1993).

In 1989 a group of Sea Otters was reported in the Goose Island Group, 125 km northwest of Vancouver Island (Figure 3). Single Sea Otters were reported in the Goose Islands in 1976 (Bigg and MacAskie 1978) and subsequently, but mothers and pups were first sighted in 1989 (D. Powers, Warden, Hakai Pass Recreation Area, c/o British Columbia Parks, Caribou District, 540 Borland Street, Williams Lake, B.C. V2G 1R8, personal communication). The origin of these Sea Otters is unknown.

Sea Otters were reintroduced to various sites in southeast Alaska from 1965 -1969 (Jameson et al. 1982; Riedman and Estes 1990) and may account for confirmed sightings off the north end of the Queen Charlotte Islands. In 1969 and 1970, Sea Otters were translocated to Washington State (Jameson et al. 1986). Animals from this population may account for some of the reports of Sea Otters off southern Vancouver Island and in the Strait of Georgia. The California Sea Otter population, a relict group, extends from about Ano Nuevo Point to Point Sal (Riedman and Estes 1990b; J. Estes, National Biological Survey, University of California, Santa Cruz, California 95064, personal communication).

Protection

Sea Otters were protected in 1911 under the International Fur Seal Treaty signed by the United

States, Russia, Japan and Great Britain (for Canada). In Canada, Sea Otters are protected under the Federal Fisheries Act and the British Columbia Wildlife Act and Regulations. Sea Otters were designated as an "endangered" species by COSEWIC and under the British Columbia Wildlife Act in 1980. MacAskie (1987) retained this designation. In the United States, Sea Otters are protected by the Marine Mammal Protection Act of 1972, which prohibits their take or harassment except for public display or scientific research. Aboriginal peoples of Alaska are permitted to take Sea Otters for traditional use. Sea Otters in California, which are considered a separate subspecies (Wilson et al. 1991), are designated as "threatened" under the U.S. Endangered Species Act of 1972 (Estes 1990b).

Population Size and Trends

Before commercial exploitation, the worldwide population of Sea Otters was between 150 000 and 300 000 animals, although these estimates are highly speculative, and some authors suggest this number may have been much larger (Kenyon 1969; Johnson 1982). Since their protection the species has recovered in many areas. Sea Otters from the northern Gulf of Alaska, through the Aleutian archipelago to the Kuril archipelago are probably at or near equilibrium density throughout much of their range (Estes 1990b). Recently reintroduced or remnant populations in southeast Alaska, British Columbia, Washington and California are increasing in size.

The British Columbia Sea Otter population, now well established with at least 1522 animals, originated from the 89 animals reintroduced from 1969 to 1972. Population surveys, conducted from fixed-wing aircraft, helicopters and small vessels, indicate the British Columbia Sea Otter population has increased at a finite rate of 18.6% per year from 70 animals in 1977 to 1522 animals in 1995 (Table 1, Figure 4, Watson 1993). This rate, which may be near r_{max} (Caughley 1977), is similar to that of reintroduced populations in southeast Alaska and Washington State, and is almost identical to the instantaneous rate of 17.7% per year calculated by Estes (1990a) using 1977, 1984, and 1987 data. Estes (1990a) suggests that if this growth curve is extrapolated back in time, the translocated population had declined to 28 individuals by 1973. At present, portions of the British Columbia Sea Otter population may be at equilibrium density (Watson 1993).

Habitat

Sea Otters inhabit shallow coastal waters, seldom ranging more than 1 to 2 km from shore, usually foraging to depths of 30 m or less (Riedman and Estes 1990). Sea Otters forage in areas with rocky

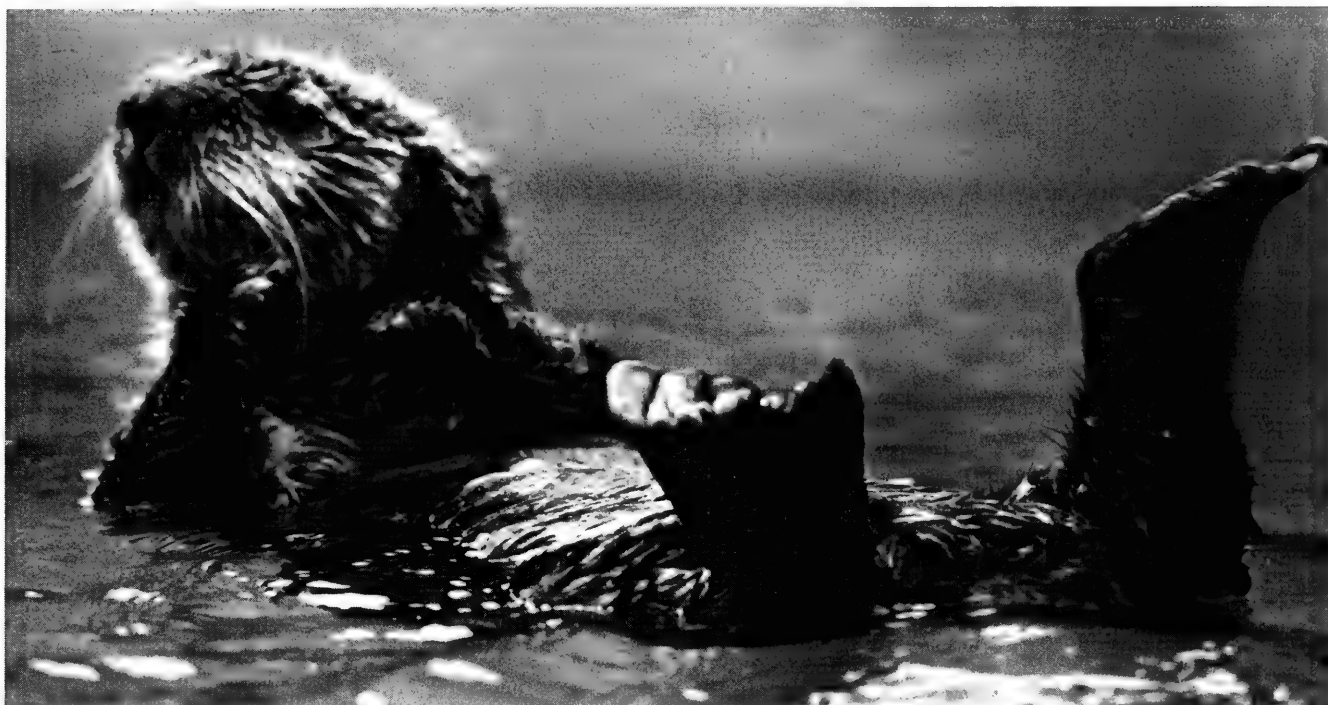


FIGURE 1. The Sea Otter, *Enhydra lutris*. Photo courtesy Vancouver Aquarium.

or soft substrate (Riedman and Estes 1990). Sea Otters, especially mothers with pups, appear to prefer areas with kelp canopies. Kelp, however, is not an essential habitat requirement, because large populations of Sea Otters occur in areas which lack extensive kelp beds (Riedman and Estes 1990). Habitat use varies with weather and sea state. Off Vancouver Island, for example, Sea Otters move offshore during extended periods of calm, and congregate in sheltered inshore areas during storms (Morris et al. 1981; Watson 1993).

In British Columbia, Checleset Bay Ecological Reserve 109 was established in 1981 to protect Sea Otter habitat. Sea Otters off Goose Island are located within the boundaries of Hakai Pass Recreational Area. However, these areas are under provincial jurisdiction and are only partially exempt from commercial shellfish harvest, which is under federal jurisdiction.

General Biology

Reproductive Capability

Most female Sea Otters reach sexual maturity at three years or older (Bodkin et al. 1993) and males between 5 and 6 years of age (Riedman and Estes 1990). Sea Otters bear a single pup at approximately one-year intervals (Bodkin et al. 1993). Pups are usually born in the water and twinning is rare (Kenyon 1969).

The number of large, dependent pups present off Vancouver Island in July suggests a peak parturition period from approximately April to July, as also observed in Alaska (Payne and Jameson 1984; Garshelis et al. 1984; Riedman and Estes 1990;

Watson 1993; Bodkin et al. 1993). However, pupping can occur year round. The period of pup dependency varies between individuals, but rarely exceeds one year (Riedman and Estes 1990; Bodkin et al. 1993).

In British Columbia, annual estimates of the population birth rate (pups/adult) range from 0.12 to 0.33 (Watson 1993). Similar rates are reported for Alaska (0.30 pups/adult) and California (0.20 pups/adult), although the pupping period is more extended in California, making it difficult to compare population birth rates (J. Estes, personal communication). It should be noted that pup abundance is easily over or under-estimated if areas of high and low pup production are not equally surveyed (Simon-Jackson 1986; Jameson et al. 1986; Estes 1990a).

Species (Individual) Movement

Sea Otters are not migratory. Patterns of movement and social organization in British Columbia appear similar to those observed in Alaska and California. Sea Otters segregate by sex and age, although patterns vary somewhat with season. In general, males and females rest in different locations. Adult males occupy territories that overlap female areas especially during the autumn breeding season. In California and Alaska large groups of males are found at the edges of the sea-otter range. These groups are composed of subadult and adult males, with breeding males joining them outside of breeding season. Males generally expand into new areas first whereas females use areas which have been occupied by Sea Otters for longer periods, and expand into areas as they are vacated by male

TABLE 1. Maximum estimates of the British Columbia Sea Otter population from aerial and boat surveys conducted from 1977 to 1995. The population is broken up into groups including Checleset Bay, Kyuquot Sound, Nuchatlitz Islands, Nootka Island, Brooks Peninsula, Quatsino Sound, and Goose Island. Conditions did not permit surveys of areas marked "-". Superscripts indicate survey method: 1 - fixed-wing aircraft, 2 - helicopter, 3 - small vessel, * incomplete survey.

Year	Total Count	Checleset Bay	Kyuquot Sound	Nuchatlitz Islands	Nootka Island	Brooks Peninsula	Quatsino Sound	Goose Group	Source
1977	70	55			15				Bigg and MacAskie 1977 ¹
1978	67	51			16				Morris et al. 1979, 1981 ¹
1982	116	97			19				Bigg unpublished ¹
1984	345	196			149				MacAskie 1984 ^{1,3}
1987	373	234			139				Bigg and Olesiuk unpublished ¹
1988	357	204			153				Watson 1993 ¹
1989	582	329	25		216		12		Watson 1993, MacAskie unpublished ^{2,3}
1990	668	288	173	5	138		8	56	Watson 1993, Powers 1989 unpublished ^{2,3}
1991	-	230	66	7	-	80	-	112	Watson 1993 ³
1992	-	257	48	227	-	116	-	168	Watson unpublished - B.C. Parks ^{2,3}
1993	1123	271	103	198	166	245	5	135	Watson et al. 1993 unpublished ³
1994	-	413	397	149	125	96	4	-	Watson et al. 1994 unpublished ³
1995	1522	530	252	149	257	85	150	99*	Watson (this report)

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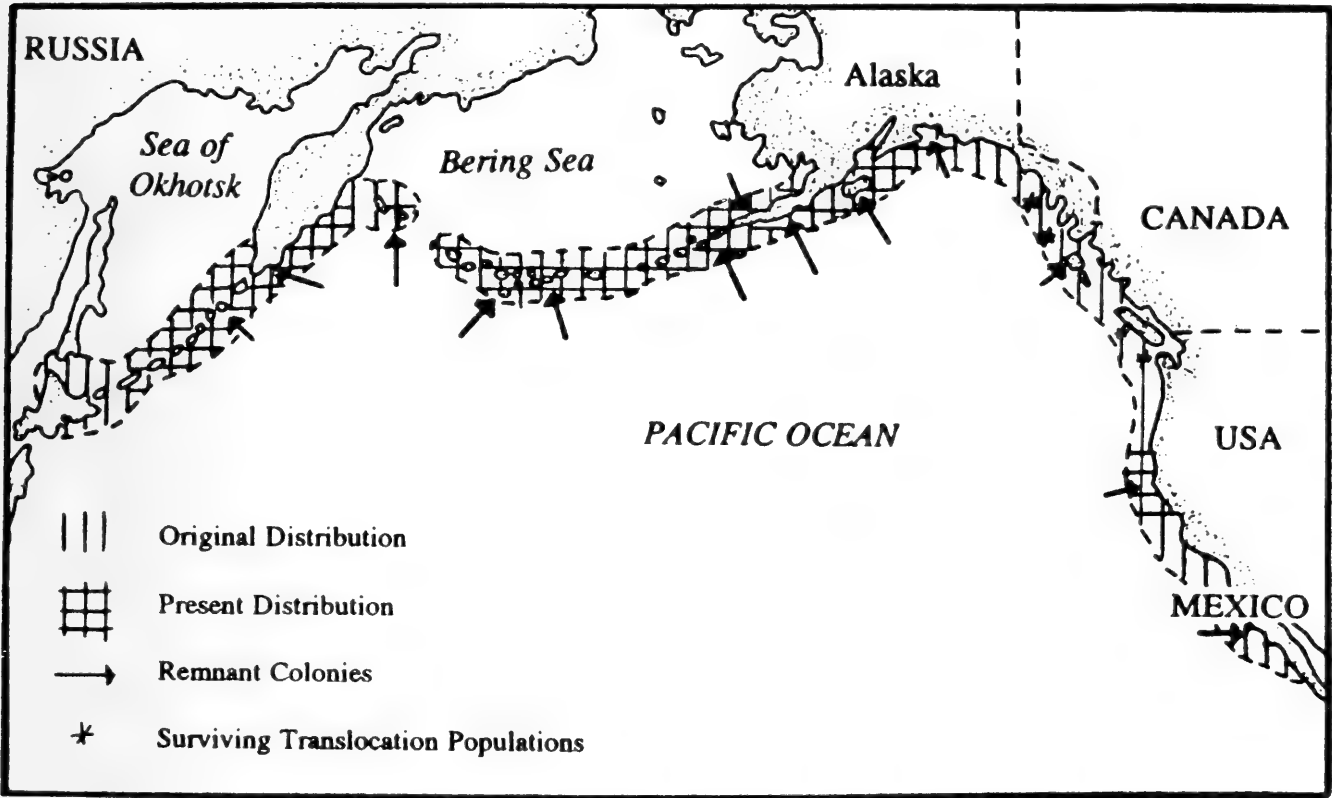


FIGURE 2. Historic and present distribution of Sea Otters, with remnant colonies and translocated populations marked.

groups (Loughlin 1980; Ribic 1982a, 1982b; Garshelis et al. 1984; Wendell et al. 1986; Pitcher 1989; reviewed in Riedman and Estes 1990).

Both male and female Sea Otters establish home ranges (Jameson 1989), the size of which depends, to a large degree, upon season. The home ranges of

males are substantially larger than those of females, which reflects seasonal movement of breeding males. Females are sedentary by comparison. Daily movement patterns vary with the territorial status of the male and whether or not a female has a pup (Jameson 1989, review in Riedman and Estes 1990).

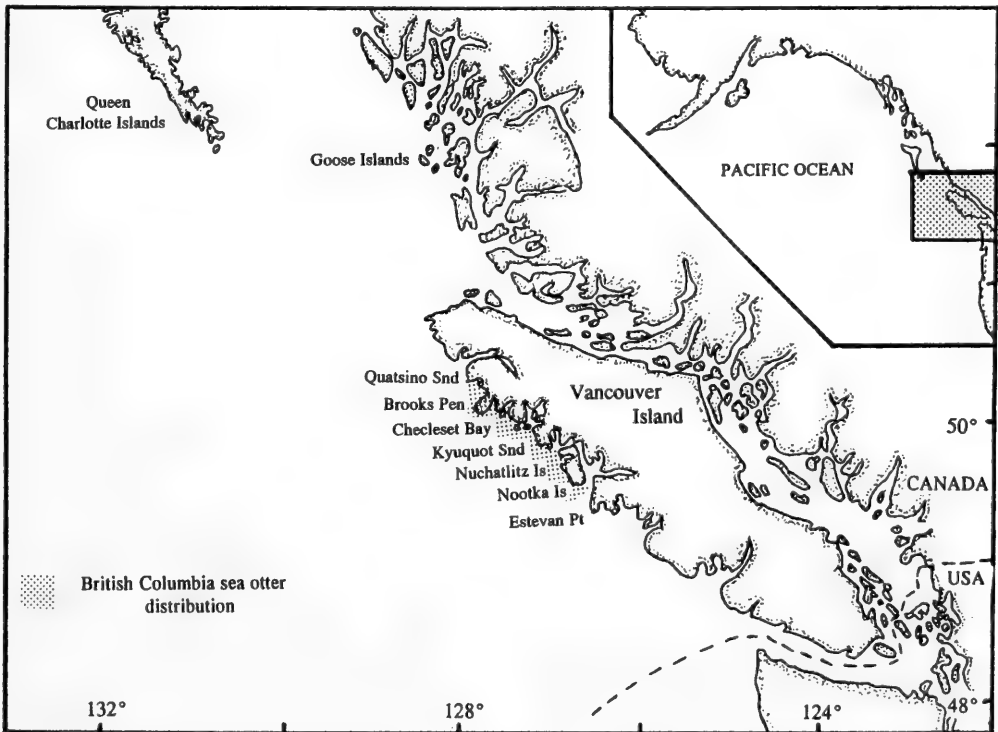


FIGURE 3. The distribution of the British Columbia Sea Otter population.

Behaviour / Adaptability

Sea Otters in British Columbia are wary of humans and easily disturbed by boat traffic. Females with pups seem most sensitive to disturbance. As these areas become more utilized by tourists, Sea Otters may become less wary. Sea Otters adjacent to inhabited areas habituate to the presence of humans (e.g., Woolfenden 1985).

There is substantial variation in the diet of individual Sea Otters. Sea Otters are highly adaptable in their diet, often exploiting seasonally abundant food resources such as spawning squid (Riedman and Estes 1990) or pelagic red crab during El Niño events (*in* Riedman and Estes 1990). In one notable example, a male otter learned to bite into discarded aluminum cans to obtain octopus which hid inside the cans (McCleneghan and Ames 1976). In California, Sea Otter dietary preferences appear to be maternally transmitted (Lyons 1989).

Sea Otters feed principally upon shellfish. However, in parts of Alaska, where Sea Otters have been long established, fish are also an important food (Estes 1977). The high proportion of fish in the diet of Sea Otters in these areas may be associated with an increase in fish abundance and decline in shellfish abundance (Estes et al. 1978). Estes (1990a) speculated that inclusion of fish in the diet of Sea Otters may increase the equilibrium density of otter populations. Foraging on fish may be a feeding strategy lost to many populations when Sea Otters were reduced to a few remnant colonies at the end of the fur hunting era (Estes et al. 1989). Sea Otters have not been observed feeding on fish in British Columbia.

Limiting Factors

Fur hunting in the 18th and 19th centuries was responsible for the extirpation of Sea Otters throughout most of their range. Today, the worldwide otter population continues to rise, with further increases expected as long as unoccupied habitat is available (Estes 1990b).

Food limitation is probably the major cause of death in Sea Otter populations at or near equilibrium density (Riedman and Estes 1990). Other than humans, predators include Bald Eagles, *Haliaeetus leucocephalus* (Sherrod et al. 1975); Killer Whales, *Orcinus orca* (*in* Riedman and Estes 1990); and sharks (Ames and Morejohn 1980). Sources of Sea Otter mortality have not been studied in British Columbia. However, pup carcasses found at eagles' nests, suggested that Bald Eagle predation on pups may represent a substantial source of pup mortality. Killer Whales, although probably an insignificant source of mortality, have been seen pursuing and consuming Sea Otters in Kyuquot Sound, British Columbia (Watson 1993) and at Amchitka Island, Alaska (J. Estes, personal communication). One

otter carcass recovered near Kyuquot, British Columbia, had injuries which could have been caused by a boat propeller (G. Ellis, unpublished).

Human-related threats to Sea Otters are localized and include environmental contamination, conflict with commercial fisheries, incidental take, and the possibility of the resumption of hunting by native peoples.

Environmental Contamination

Perhaps the greatest threat to Sea Otters is that of oil spills (Geraci and St. Aubin 1980; Geraci and Williams 1990; Ralls and Siniff 1990). Sea Otters are vulnerable to oil in several ways. Oil destroys the water-repellent property of the fur, allowing cold water to contact the skin, which may result in hypothermia. Inhalation of volatile petroleum vapors injures lungs and other organs. Lastly when oil is ingested through grooming or foraging it injures internal organs (Geraci and Williams 1990). Furthermore, Sea Otters spend much of their time in kelp beds which retain oil, and congregate in groups, which means large numbers of Sea Otters can be exposed to oil simultaneously (Ralls and Siniff 1990).

Although methods for cleaning and rehabilitating oiled otters have been developed (Costa and Kooyman 1984; Davis et al. 1988; Geraci and Williams 1990; Degange et al. 1995; Williams and Davis 1995), their effectiveness, at a population level, has been questioned (Estes 1991). On 24 March, 1989 the oil tanker *Exxon Valdez* ran aground in Prince William Sound, spilling 10 million gallons (37.8 million l) of crude oil. At least 1013 Sea Otters were killed (Bayha and Kormendy 1990; Estes 1991; Ballachey et al. 1994); additional carcasses undoubtedly sunk and were not recovered. On 22 December 1988, 231 000 gallons (875 000 l) of oil from the barge *Nestucca* spilled and spread northwards from Grays Harbour, Washington. This relatively small spill killed at least one Sea Otter in Checleset Bay, British Columbia (Waldichuck 1989; Watson 1990, 1995). The continued transportation of oil along the coast of British Columbia poses a significant threat to British Columbia's Sea Otter population.

The effect of environmental toxins on Sea Otters has not been well documented, although varying levels of chlorinated-hydrocarbons and heavy metals have been found in sea-otter tissue (Riedman and Estes 1990). The high rate of population growth observed throughout much of the Sea Otters' range, suggests that environmental toxins are not at present a significant threat to Sea Otters (Riedman and Estes 1990), although recent evidence suggests that locally high levels of environmental toxins may affect pre-weaning mortality in Sea Otters (J. Estes, personal communication; Bacon 1994).

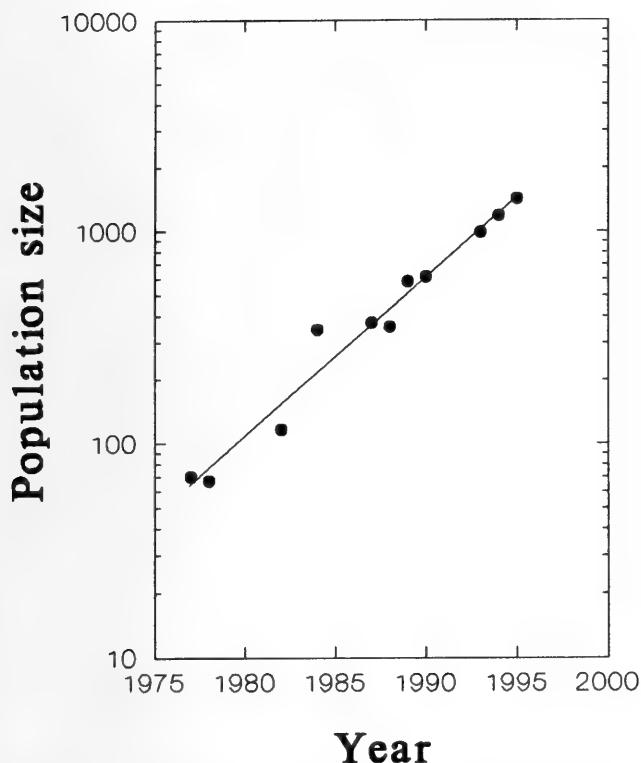


FIGURE 4. Growth of the British Columbia Sea Otter population from 1977–1995. The population has increased at a rate of 18.6% per year ($r^2=0.969$) since 1977. Estimates of the Sea Otter population off of Goose Island are not included, because the size of this group is poorly known.

Fishery Conflicts

Sea Otters are capable of limiting the abundance of many commercial species of shellfish (Johnson 1982; Estes and VanBlaricom 1985; Pitcher 1989). This has resulted in considerable conflict between commercial shellfish harvesters and Sea Otters (Estes and VanBlaricom 1985). Sea Otters have had a significant effect upon the Pismo clam fishery in central California (Wendell et al. 1986), clam density in Alaska (Kvitek et al. 1992; Kvitek and Oliver 1992) and sea urchin abundance in parts of British Columbia (Morris et al. 1979, 1981; Breen et al. 1982; Watson 1993). Conflicts over Sea Otters and shellfish stocks are not yet a problem in British Columbia, but can be anticipated as the geographic range of Sea Otters increases (Watson and Smith 1996).

Incidental Take of Sea Otters

Gill-net fisheries in California have probably limited or even reduced the southern Sea Otter population (Wendell et al. 1985). Incidental take of Sea Otters in net-fisheries in southeast Alaska and Prince William Sound have been reported, but the impact on the Sea Otter population is unknown (Matkin and Fay 1980; Simon-Jackson 1986). Gill-nets are used

in both salmon and herring fisheries in British Columbia, but incidental take of Sea Otters has not been reported. The expansion of Sea Otters into areas where gill-net fisheries, particularly for salmon, occur could have local effects on Sea Otter abundance.

Special Significance of the Species

Once on the verge of extinction, Sea Otters have made a remarkable recovery, largely because of protective legislation, an abundance of suitable unoccupied habitat and successful reintroductions (Mason and Macdonald 1990). The worldwide population of Sea Otters is thought to be about 150 000 animals, most of which are found from the Gulf of Alaska and westward across the Aleutian archipelago (Estes 1980; Riedman and Estes 1990).

The "teddy-bear-like" appearance of Sea Otters, their near brush with extinction, their important role in nearshore community structure and their vulnerability to oil spills has endeared them to the public. Sea Otters do well in captivity and are popular at zoos and oceanaria. Sea Otters use rocks and other hard objects as tools to crack the exoskeletons of their prey. With the exception of primates, Sea Otters are the only mammal known to use tools.

The Sea Otter, *Enhydra lutris*, is the sole member of the genus *Enhydra*. Three subspecies are recognized; *Enhydra lutris lutris* which is found from the Kuril Islands to the Commander Islands; *Enhydra lutris kenyoni* (Wilson et al. 1991) which historically occurred from the Aleutian Islands to Oregon, and *Enhydra lutris nereis* or the southern Sea Otter, which is presently found only in California. The historic range of the southern Sea Otter is disputed (Riedman and Estes 1990).

In the United States, the Marine Mammal Protection Act allows aboriginal people in Alaska to harvest Sea Otters for traditional use (Samuel and Foin 1983; Simon-Jackson 1986). The number of Sea Otters harvested in this fishery has increased dramatically in recent years, from 55 animals in 1988 to 1248 in 1993 (J. Bodkin, National Biological Survey, 1011 East Tudor Road, Anchorage, Alaska 99503, personal communication). The impact of this harvest on local Sea Otter populations is unknown (Estes 1990b).

Sea Otters exert a significant effect upon the structure of rocky nearshore communities (Estes and Palmisano 1974; Estes et al. 1978, 1989). By feeding on herbivorous invertebrates, particularly sea urchins, Sea Otters reduce grazing pressure and increase the growth of fleshy algae, particularly brown algae such as kelp (Estes et al. 1978; Breen et al. 1982; Watson 1993). Consequently, rocky nearshore communities in areas occupied by Sea Otters are often characterized by an abundance of

fleshy algae, whereas areas without Sea Otters are dominated by sea urchins and fleshy algae are rare (Estes and Duggins 1995).

Evaluation

Although aboriginal hunting may have locally extirpated Sea Otters prior to the arrival of Europeans (Simenstad et al. 1978), Sea Otter populations were driven to the brink of extinction by an intensive fur hunt commencing in the 1740s. Sea Otters were protected in 1911, and have subsequently increased to historic levels throughout much of their range. In British Columbia, the reintroduced Sea Otter population is increasing at near maximum rate (Estes 1990a; Watson 1993).

Despite increases in the size and geographic extent of Sea Otters in British Columbia, the population is still relatively small in size and restricted in distribution, making it vulnerable to environmental catastrophes such as oil spills. The species is no longer in danger of imminent extirpation from Canadian waters, but is still vulnerable and should remain in a category of risk which will ensure continued protection and management. A downlisting to "threatened" would retain their status on the COSEWIC list as a species which could become endangered if the factors limiting its distribution and numbers are not controlled.

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Status of the Northern Bottlenose Whale, *Hyperoodon ampullatus*, in the Gully, Nova Scotia*

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A population of approximately 230 Northern Bottlenose Whales, *Hyperoodon ampullatus*, uses the Gully, a prominent submarine canyon on the edge of the Scotian Shelf. These animals use the Gully throughout the year. Approximately 57% of the population reside in a 20 km × 8 km core area at the entrance of the canyon at any time. The Gully animals seem to be largely or totally distinct from the population seen off northern Labrador: they are smaller and appear to breed at a different time of year. Threats to the population include commercial shipping, fishing and oil and gas developments. One oil and gas discovery of commercial interest, the Primrose Field, lies about 5 km from the core area of this population. The population is vulnerable because of its small size, location at the extreme southern limit of the species' range, and year-round dependence on a small and unique sea area. It is threatened by plans for the development of the oil and gas fields close to the Gully.

Une population d'environ 230 baleines à bec communes, *Hyperoodon ampullatus*, se trouve dans le Gully, un canyon sous-marin important situé sur le bord de la Plate-forme Néo-Ecossaise. Les animaux fréquentent le Gully à l'année longue. Environ 57% de la population réside en tout temps dans une aire de 20 km × 8 km à l'entrée du canyon. Les animaux du Gully sont en grande partie sinon totalement distincts de ceux des populations arctiques de cette espèce, étant plus petits et semblant se reproduire à une période de l'année différente. Les facteurs menaçant la population comprennent la navigation commerciale, la pêche et la présence de ressources pétrolières et gazières potentiellement exploitables. L'une des découvertes de pétrole et de gaz d'intérêt commercial, le gisement Primrose, se situe à 5 km de l'aire principale de cette population. Cette dernière est vulnérable de par son petit nombre d'individus, sa situation à la limite extrême sud de l'étendue de distribution de l'espèce et sa dépendance à l'année longue envers une petite zone marine unique. La population est menacée par des projets de développement de gisements de pétrole et de gaz à proximité du Gully.

Key Words: Northern Bottlenose Whale, baleine à bec commune, *Hyperoodon ampullatus*, Cetacea, Odontoceti, the Gully, submarine canyon, Nova Scotia.

In this report we evaluate the status of the population of Northern Bottlenose Whales, *Hyperoodon ampullatus* (Forster 1770) whose members are found in the Gully, a submarine canyon on the edge of the Scotian Shelf. The Northern Bottlenose Whale (Figure 1) is a 6- to 9-m member of the beaked whale family (Ziphiidae) resident only in the northern regions of the North Atlantic. Its closest relative is the Southern Bottlenose Whale (*Hyperoodon planifrons*) of the Southern Oceans. Bottlenose whales seen in the tropical Pacific may be *Hyperoodon planifrons* or an unnamed species (Klinowska 1991). The biology of the Northern Bottlenose Whale was reviewed by Benjaminsen and Christensen (1979) and Mead (1989). The general status of the species in the North Atlantic was described by Reeves, Mitchell and Whitehead (1993).

Distribution and Stock Identity

Northern Bottlenose Whales are present consistently, throughout the year, in a 20 km × 8 km "core

area," at the entrance of the Gully, a submarine canyon on the edge of the Scotian Shelf (Faucher and Whitehead 1991; Reeves, Mitchell, and Whitehead 1993; Figure 2). They are also sighted, more rarely, off the edge of the Scotian Shelf to the east and west of the Gully (Figure 2), and there are very occasional reports from the edge of the U.S. Shelf (Reeves, Mitchell, and Whitehead 1993). During the Canadian Patrol Frigate Shock Trials in November 1994, Northern Bottlenose Whales were observed twice and heard once near the detonation site (42° 05'N 61° 20'W), 110 km from the Shelf Break and 200 km from the Gully (Parsons 1995; Figure 2).

The Gully is the southernmost area in the western North Atlantic where Northern Bottlenose Whales are found on anything other than on a very occasional basis. The nearest other region where the species may be consistently sighted is off northern Labrador, 1400 km to the north.

Analysis of photographic identifications of individual whales suggests that the animals in the Gully

*Reviewed and Approved by COSEWIC 16 April 1996 - status assigned: Vulnerable.



FIGURE 1. Northern Bottlenose Whale photographed in the Gully showing signs of entanglement in fishing gear.

at any time are about 57% of a population numbering about 230 animals (Whitehead et al. 1997; H. Whitehead, unpublished). The geographic range of this population is unknown but, based on the pattern of sightings, we suspect that it is principally the slope waters south of Nova Scotia. If the Gully animals are an integral, freely-mixing part of the population off northern Labrador, then the total population numbers only about 230 animals — unlikely given the numbers and geographical spread of recent sightings in northern waters (Reeves, Mitchell and Whitehead 1993).

The population analysis (Whitehead et al. 1997) does not rule out occasional migrations of animals between the northern (Labrador-Davis Strait) areas and the Gully. The estimates of mortality + emigration + mark change are about 12% per year, and have wide confidence limits. We have no objective means of allocating the 12% between these three possible causes. No estimates of mortality are available for Northern Bottlenose Whales, although mortality is believed to be about 6% per year in the Sperm Whale (*Physeter macrocephalus*), the species most ecologically similar to the Northern Bottlenose for which data are available (Rice 1989). Thus we can only conclude from the population analysis that emigration rates from the Gully population, and immigration rates into it, are probably less than about 10% per year and may be negligible.

Additional evidence that the Northern Bottlenose Whales in the Gully are largely distinct from those off Labrador comes from an examination of length distributions (Whitehead et al. 1997). The photo-

graphically measured animals in the Gully are about 0.7 m shorter than those caught off northern Labrador. The same effect is true for the two sexes: the Labrador population is 0.55 m larger for all males, 0.94 m for females. Some of the difference could be due to differential selection by the whalers and our photographic measurement methods. However, this cannot account for all the difference: about 10% of the Labrador population were greater than 8.5 m long, but animals this large were virtually absent from the Gully. It is possible that only young animals visit the Gully. However, we do see distinctive mature males as well as females with calves. A 6.15 m male with five growth layers in its teeth which stranded in the Bay of Fundy, and was thus likely from the Gully population, lay below the growth curve for animals caught in Labrador (Mitchell and Kozicki 1975) and is further evidence that individuals in the Gully population are smaller than those from Labrador.

Our observations also indicate that the Bottlenose Whales of the Gully may be on a different breeding schedule to the Labrador population, which mates and gives birth in April (Benjaminsen 1972). In the Gully, we have five high-quality measurements (probably representing two calves) of 3.0 to 3.3 m in August, and none between 3.3 to 4.0 m. Mead (1989) suggests 3.5 m for the mean length at birth of the populations studied in northern waters. Thus, even allowing for smaller animals in the Gully, the 3.0 to 3.3 m calves observed in the Gully in August were likely recently born. The gestation period of Bottlenose Whales is about 12 months so that mat-

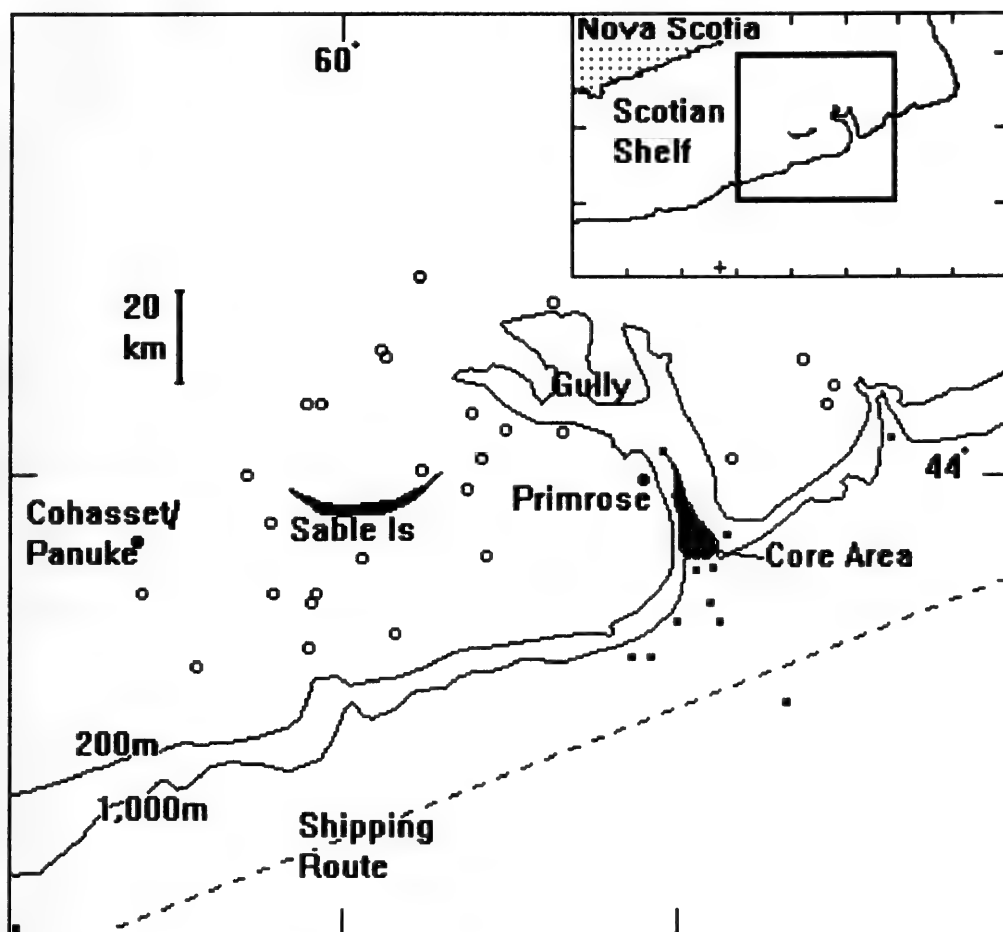


FIGURE 2. The Scotian Shelf, showing the Gully, oil and gas discoveries from Wade et al. (1989) (circles, the Cohasset/Panuke and Primrose fields are filled), major shipping route (dashed line), the core area of the Northern Bottlenose Whale population (shaded), and additional sightings and catches of the species (■) from Reeves, Mitchell and Whitehead (1993), the Sea Education Association and our own sightings. The site of the Canadian Patrol Frigate Shock Trial at which Bottlenose Whales were sighted is marked on the inset by a "+".

ing and calving occur at the same time of year (Benjaminsen and Christensen 1979). In the Gully, the proportion of mixed groups of males and females rises through June-August (proportion of groups with both adult males and females: 10% June; 17% July; 28% August), consistent with an August mating/parturition season.

Protection

National legislation and international conventions protecting Northern Bottlenose Whales from hunting are described by Reeves, Mitchell and Whitehead (1993). Neither now, nor in the near future, is the population in the Gully likely to be subject to whaling.

Several initiatives have been undertaken to protect the Gully population. In 1990, the oil company, Lasmo, which was beginning exploitation the Cohasset-Panuke field 110 km to the west of the Gully, declared a "tanker exclusion zone" including the Gully, so that shipping associated with the

development does not interfere with the whales. The Department of Fisheries and Oceans has designated a "Whale Sanctuary" in the Gully for the Northern Bottlenose Whales and, in the Canadian Notices to Mariners Annual Edition (1994), published guidelines for the behaviour of vessels within the sanctuary. Shipping companies have been asked (by letter) to avoid the area, and many have agreed to do so. The establishment of a Marine Protected Area in the Gully is being considered by the Canadian Wildlife Service, the Department of Fisheries and Oceans, Parks Canada, World Wildlife Fund Canada and other organizations and individuals (Amirault 1995).

Population Sizes and Trends

The population of Northern Bottlenose whales in the Gully has been assessed using mark-recapture methods on photographic individual identifications collected between 1988 and 1995 (Whitehead et al., 1997). This analysis suggests a population of about

230 animals (approximate 95% confidence interval 160-360). Data are insufficient to detect any trends in population size.

Eighty-seven Northern Bottlenose Whales were taken by whalers working from Blandford, Nova Scotia between 1962-1967 (Reeves, Mitchell, and Whitehead 1993). The great majority of these seem to have been killed in, or near, the Gully (Reeves, Mitchell, and Whitehead 1993). Assuming that the population size is now somewhere between its levels immediately before and after this whaling, a 29 to 41% reduction in numbers during the whaling period is indicated.

Habitat

The habitat of the Bottlenose Whales south of Nova Scotia is the waters near the edge of the continental shelf which are greater than 1000 m deep, but the overwhelming focus of their distribution is the 20 km x 8 km core area at the entrance of the Gully. In terms of relief, and penetration into the shelf, the Gully is the most prominent canyon in the western North Atlantic. The whales are never seen in waters less than about 800 m deep, even though such depths are within a few km of their core habitat.

Protection of this core habitat is likely to be essential for the survival of the population.

General Biology

The general biology of Northern Bottlenose Whales was described by Benjaminsen and Christensen (1979), Mead (1989) and Reeves, Mitchell and Whitehead (1993).

Limiting Factors

The size of the population that uses the Gully is small, about 230 animals. This is well below the 2000 beneath which IUCN (International Union for the Conservation of Nature) classifies cetacean species as Endangered (Klinowska 1991). However, the Gully Bottlenose Whales, although apparently largely or totally distinct from the populations in more northern waters, are not (as far as we know) a different species. It seems likely that the population is naturally small, limited by available habitat in the area to the low hundreds.

The Gully population is at the extreme southern limit of the species' range in the western North Atlantic. This likely limits the potential for alternative suitable habitat in nearby sea areas.

The proximate threats to these animals from humans are principally:

Collisions with ships. Each year a number of whales are found dead in the waters off Nova Scotia following collisions with shipping (J. Conway, Department of Fisheries and Oceans, Scotia-Fundy Region, Halifax, Nova Scotia; personal communication),

although there are no known reports of Bottlenose Whale fatalities.

Acoustic pollution. Whales communicate and sense their environment largely through the acoustic channel. Noise affects the behaviour and movement of whales; it has the potential to interfere with feeding or mating, or cause physiological damage (Richardson et al. 1991; Committee on low-frequency sound and marine mammals 1994).

Fishing Gear. Entanglement in fishing gear (that in active use as well as discarded, abandoned or lost gear) is a major threat to many cetacean populations (Cooke 1991). A number of the Bottlenose Whales in the Gully show evidence of encounters with fishing gear (e.g., Figure 1).

Marine Debris. Entanglement in floating debris, such as plastic bags and discarded strapping, is a source of mortality for many marine animals, including cetaceans (Cooke 1991). The Gully has a high level of such pollution (Dufault and Whitehead 1994).

Chemical Pollution. The most obvious sources of these dangers are commercial shipping, fishing activity and petrochemical exploration and exploitation. Explosions and loud underwater sounds made for naval and scientific purposes may also pose a threat (Richardson et al. 1991; Committee on low-frequency sound and marine mammals 1994).

Ships may collide with the whales, are a source of acoustic pollution, and can contribute to marine debris and chemical pollution. The major east-west trans-Atlantic shipping route lies about 30 km south of the Gully core area (Figure 2). Commercial ships (excluding fishing vessels) transit the core area of the Bottlenose Whales about once per day (H. Whitehead, unpublished data). This rate may have decreased somewhat since the Department of Fisheries and Oceans' guidelines were published in the Notices to Mariners, and requests for avoidance were sent to shipping companies.

The shallow areas bordering the Gully were heavily dragged for groundfish, while midwater dragnets take Redfish (*Sebastes* sp.) from within the core area. Fishing vessels, especially while dragging, are extremely noisy (H. Whitehead, personal observation). They may entangle whales in their active, lost or discarded gear, and are sources of other marine debris. The crash of groundfish stocks during the last few years has considerably reduced fishing activity in the area of the Gully. Harpooning and long-lining for Swordfish (*Xiphius gladius*) also takes place in the core area but this is less obviously harmful.

Oil and gas have been found in commercially exploitable quantities on the Scotian Shelf bordering the Gully. One find, the "Primrose" Field, lies about 5 km from the core area of the Bottlenose Whales (Figure 2). The only current exploitation in the area

is at the "Cohasset/Panuke" condensate fields (Figure 2). These are 110 km from the Gully, and their exploitation probably poses little threat to the bottlenose whales. In the next few years, a consortium of oil companies led by Mobil Oil Canada plans to exploit some of the gas discoveries around Sable Island, the closest of which, the "Venture" Field, is about 45 km from the core area of the Bottlenose Whales in the Gully.

Oil and gas exploitation has the potential to harm the Bottlenose Whales directly through the noise of the drilling and other operations, spills and discarded material, but also indirectly because of an increase in shipping traffic. Noises associated with offshore oil and gas production disturbed the behaviour of Bowhead Whales (*Balaena glacialis*) to ranges of about 3 to 11 km (Richardson, Wursig, and Greene 1990). It is not known how sensitive the Bottlenose Whale is to acoustic disturbance but the most ecologically similar species for which there are any data, the Sperm Whale, is especially easily disturbed by sound (e.g., Watkins and Schevill 1975; Watkins, Moore and Tyack 1985). Bottlenose Whales have particularly weak social sounds (Winn, Perkins, and Winn 1970) which might suggest vulnerability to acoustic disturbance.

The most important limiting factor for the population of Bottlenose Whales in the Gully is likely the pattern and method of development of these oil and gas fields.

Special Significance of the Population

Our research on the Northern Bottlenose Whales in the Gully is unique: it is the only long-term study of any beaked whale population, anywhere in the world — these are the only living ziphiids to be individually identified. There are no known locations at all comparable to the Gully in terms of the potential for studies of beaked whale populations. In the near future, most of what is known about the natural behaviour of living beaked whales is likely to come from the Gully. The population is not only amenable to research: two film crews have visited the Gully, and have successfully filmed the whales; and local tourist operators are making plans to bring limited numbers of whale watchers to the Gully.

Unusual biological features of the Bottlenose Whale include their maxillary crests, their deep and prolonged dives, the types of sounds produced, and pronounced curiosity towards boats (Mead 1989; Reeves, Mitchell, and Whitehead 1993).

Evaluation

The population of Northern Bottlenose Whales in the Gully is small, about 230 animals, at the southern extreme of the species' range, and largely or totally distinct from the larger populations further

north. The animals seem to be non-migratory, spending an average of 57% of their time in a 20 km \times 8 km core area, which is bathometrically unique in the western North Atlantic. These characteristics make the population particularly sensitive to human activities. Thus the population should be, at the least, considered vulnerable.

The development and exploitation of the oil and gas fields on the Scotian Shelf is approaching the Gully, threatening the Bottlenose Whales and other inhabitants of the Gully, which include exceptional numbers of some other cetacean species (Gowans and Whitehead 1995). With exploitation of the Primrose Field, the core area of the Bottlenose Whales in the Gully may be abandoned, endangering the population. The current plans for progressive development of the oil and gas fields near the Gully suggest that this population should be designated vulnerable.

Acknowledgments

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Status of the Sperm Whale, *Physeter macrocephalus*, in Canada*

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The Sperm Whale (*Physeter macrocephalus*) is the largest of the toothed whales. Members of this species are extreme, or distinctive, among cetaceans in many ways which include their large brain size, sexual dimorphism, diving behaviour, social organization, communication system and ecological significance. They occur in all the deeper waters of the world's oceans that are not ice-covered, although females are generally restricted to areas where surface temperatures are warmer than 15°C and depths are greater than 1000 m. Sperm Whales range widely with no clear divisions between populations. Sperm Whales were depleted during two massive, world-wide hunts (peaking in approximately the 1840s to the 1860s and the 1950s to the 1970s). The current world population likely numbers a few hundred thousand, but there are considerably fewer Sperm Whales now than there were before whaling. Recovery of the population is slow because of a very low reproductive rate, possibly compounded by the lingering effects of a socially disruptive hunt concentrated on large males. Sperm Whales are found off both the east and west coasts of Canada with particular concentrations at the entrance to the Hudson Strait, on the Scotian Shelf and west of Vancouver Island. Both sexes occur off western Canada, but females only occasionally use the southern most waters off Atlantic Canada. Although no immediate threats to Sperm Whale populations are known, these animals are vulnerable to particular kinds of human disturbance, and populations may be threatened, in the long term, by increasing levels of pollutants in the oceans.

Le cachalot macrocéphale (*Physeter macrocephalus*) est le plus gros des odontocètes. Les membres de cette espèce sont extrêmes ou distinctifs parmi les cétacés à bien des égards qui comprennent leur large cerveau, leur dimorphisme sexuel, leur comportement de plongé, leur organisation sociale, leur système de communication, et leur importance écologique. Ils habitent toutes les eaux plus profondes des océans du monde où il n'y a pas une couverture de glace, bien que les femelles soient généralement limitées aux zones où les températures à la surface sont plus chaudes que 15°C et la profondeur est supérieure à 1000 m. Les cachalots parcourent tout les océans et ils n'ont aucune division distincte entre les populations. Le nombre des cachalots a été épuisé par deux chasses massives mondiales (apogée approximativement aux environs de 1840 à 1860 et encore de 1950 à 1970). Aujourd'hui, les cachalots sont considérablement moins nombreux qu'avant la pêche à la baleine bien que la population mondiale du jour est probablement quelques centaines de milliers. Le recouvrement de la population est lent à cause d'un bas taux de reproduction, et de l'effet possible d'une chasse socialement destructive qui a concentrée son attention sur les gros mâles. Au Canada, on retrouve les cachalots au large des côtes ouest et est avec des centres de convergence dans l'entrée du Détroit de Hudson, sur la plate-forme néo-écossaise, et à l'ouest de l'île de Vancouver. Au large de la Colombie-Britannique on peut retrouver les deux sexes, mais les femelles sont rarement trouvées dans les eaux les plus méridionales au large de l'Atlantique canadien. Quoique on ne connaisse aucune menace immédiate envers la population des cachalots, mais ces baleines sont vulnérables à certains dérangements provoqués par les humains et la population peut être menacée, dans le long terme, par les niveaux de polluants croissant dans les océans.

Key Words: Sperm Whale, cachalot, cachalot macrocéphale, *Physeter macrocephalus*, Cetacea, Odontoceti, conservation status, Canada.

The Sperm Whale (*Physeter macrocephalus* Linnaeus 1758) is the world's largest living odontocete, or toothed whale (see front cover). Males grow to a maximum length of 18 m and reach weights of nearly 60 metric tons. Females are much smaller, with a maximum length of about 11 m and a weight of 24 metric tons (Rice 1989). The Sperm Whale is extreme among mammals in a number of ways in addition to its large size and sexual dimorphism. It has the largest brain on Earth, and the largest geographical separation of adult males from adult females. The aggregate world biomass is among the highest of any wild mammal, and this distinction probably would have been more marked in pre-

whaling times. Sperm Whales may dive deeper than any other mammal, although they are rivalled by Elephant Seals (*Mirounga* spp.) and Bottlenose Whales (*Hyperoodon* spp.), and they seem to have one of the most caring of marine mammal societies. The world's Sperm Whale populations were the target of two massive commercial hunts. The first, using open rowed whale-boats and hand-thrown harpoons, lasted from the early 18th Century to the early 20th Century, peaking in the 1840s and 1850s. Modern whalers aboard steam or diesel powered catcher vessels with deck-mounted harpoon guns took hundreds of thousands of Sperm Whales between 1946 and 1978 (Best 1983).

*Reviewed and approved by COSEWIC 16 April 1996, status assigned: Not At Risk (NAR).

There is only one species of *Physeter*, although the appropriate nomenclature and evolutionary history of the Sperm Whale are matters of debate. Most scientists and organizations (including the International Commission for Zoological Nomenclature and the International Whaling Commission) call the Sperm Whale *Physeter macrocephalus* (Husson and Holthuis 1974; Holthuis 1987; Rice 1989). Schevill (1986, 1987), however, argued that *Physeter catodon* was the proper Linnaean name for the species. The Sperm Whale is generally classified in the suborder Odontoceti, the toothed whales, but molecular evidence has recently been interpreted as suggesting that it is more closely related to the baleen whales (suborder Mysticeti) and therefore that the odontocetes are not monophyletic (Milinkovitch, Guillermo and Meyer 1993).

This review discusses the conservation status of the Sperm Whale, with particular attention to the animals of the North Atlantic and North Pacific.

Distribution and Stock Identity

The Sperm Whale's distribution spans virtually all latitudes between the north and south polar ice caps. It has the widest distribution of any marine mammal except the Killer Whale (*Orcinus orca*) (Rice 1989). The Sperm Whale, generally an animal of deep waters, is particularly abundant off the outer edges of the world's continental and island shelves, in or near upwelling areas, and in deeper basins of seas and gulfs (Townsend 1935; Berzin 1971; Jaquet 1996). Females and young animals are generally restricted to tropical and temperate waters whereas mature males are more common at higher latitudes (Rice 1989).

Both tagging experiments carried out with the whaling industry and resightings of individually identified animals indicate that female Sperm Whales have ranges spanning very approximately 1000 km, although there is a great deal of variation (Best 1979; Kasuya and Miyashita 1988; Dufault and Whitehead 1995). Mature males have larger ranges, migrating from high-latitude feeding grounds to breed in tropical and subtropical waters (Best 1979). They also make considerable longitudinal migrations (see below).

The delineation of Sperm Whale stocks was a contentious issue at meetings of the Scientific Committee of the International Whaling Commission during the 1970s and early 1980s (e.g., International Whaling Commission 1980). Evidence from different sources was often contradictory. Part of the problem lay in the very different ranging patterns of males and females, but the weight of evidence suggests that there are no well-defined Sperm Whale stocks – no areas in the ocean which Sperm Whales rarely cross, or even areas which they rarely cross at a particular time of year. For instance female

Sperm Whales which visit the Galápagos Islands also use waters off mainland Ecuador, 1000 km away, where they mix with females which do not visit the Galápagos (Dufault and Whitehead 1993). In a study of variation in the maternally-inherited mitochondrial DNA of female Sperm Whales, strong group-level similarities among females were found, indicating genetic relatedness within groups, but no geographic structure at any scale: females in different groups in the same area were as likely to share mitochondrial haplotypes as those in different oceans (Dillon 1996). Thus it seems that groups of female Sperm Whales, and individual males, have ranges, but that the population has no other clear geographic structure.

North Atlantic

The overall North Atlantic distribution of adult males extends north to at least 69°N in Denmark Strait and to 71°N west of Jan Mayen and north of Norway (Rice 1989). Sperm Whales are found in the Caribbean Sea, the Gulf of St Lawrence and the Mediterranean Sea (Viale 1977; Rice 1989; see below). In the Atlantic, females and young males rarely move north of the Subpolar Convergence (45 to 50°N, farther north in the east than the west).

Off the east coast of Canada, Sperm Whales have not been reported north of Hudson Strait, although they certainly move into higher latitudes (at least to 64°N) off West Greenland (Kapel 1979; Perkins et al. 1982). The lack of records off the east coast of Baffin Island may be due partly to the whales' off-shore distribution and the small amount of research effort there. Large males are common at the eastern entrance to Hudson Strait in late August and September (Mitchell 1974; MacLaren Atlantic Limited 1977; MacLaren Marex Inc. 1979), and some enter Hudson Strait and Ungava Bay (Reeves et al. 1986). Male Sperm Whales are present off, and sometimes on, the continental shelf along the entire east coast of Canada south of Hudson Strait (e.g.; Mitchell 1974; 1975; Mitchell and Kozicki 1984; Whitehead, Brennan, and Grover 1992; Parsons 1995; Figure 1). They are found with considerable reliability in the northern part of the Gully (44°N, 59°W), a submarine canyon on the edge of the Scotian Shelf (Whitehead, Brennan and Grover 1992). Sperm Whales are found in the Gulf of St. Lawrence, usually only sporadically and in relatively small numbers (Richard Sears, Mingan Island Cetacean Study, 285 Green Street, St. Lambert, Quebec; personal communication), although one to four Sperm Whales, including one well-known individual, "Tryphon", were seen off Tadoussac in the St. Lawrence Estuary quite consistently during the summer months (May-October) between 1991 and 1995 (R. Michaud, GREMM, Tadoussac, Quebec; personal communication).

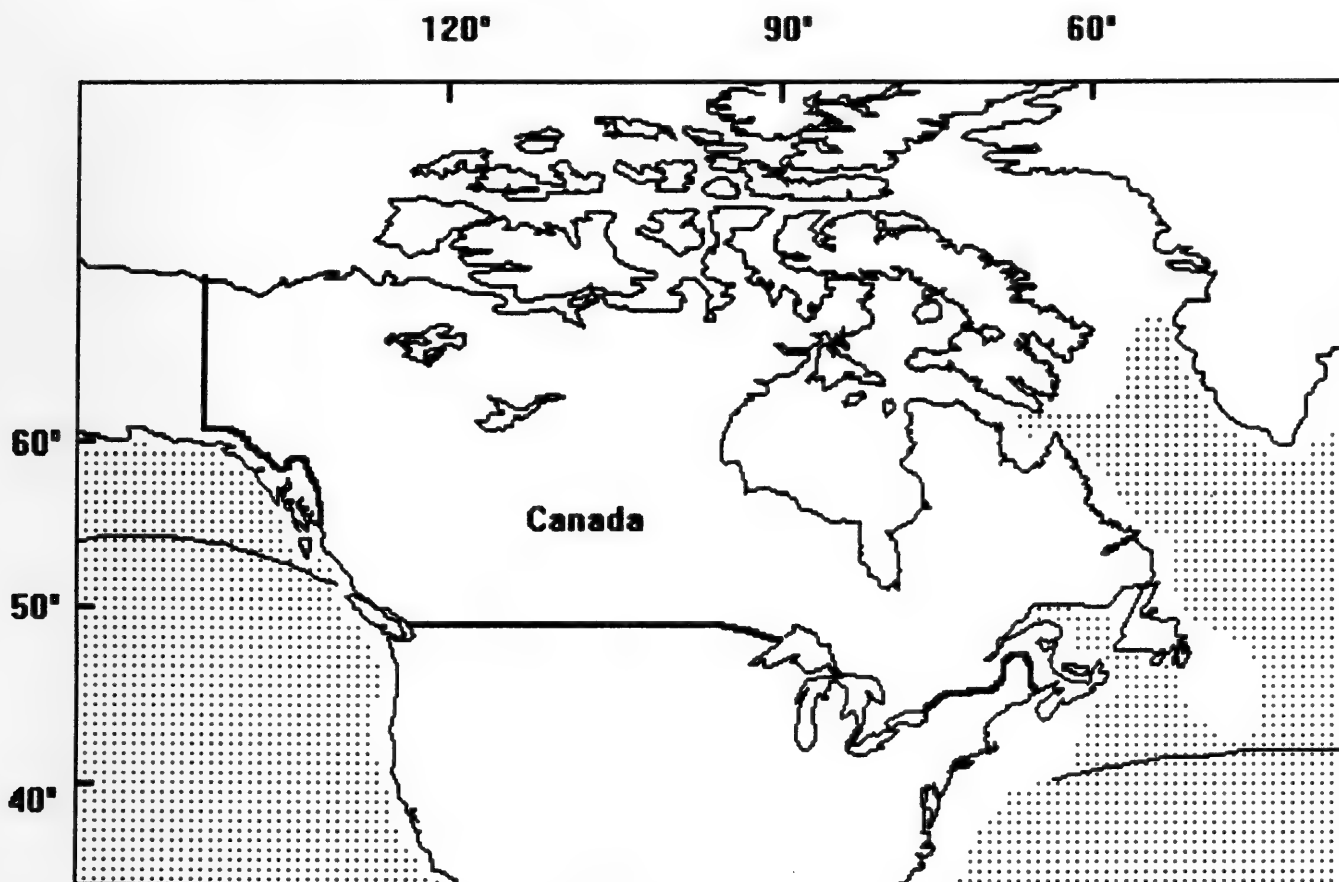


FIGURE 1. Approximate distribution of Sperm Whales in waters near Canada. The approximate northern limit for females is shown by a solid line in both the North Pacific and North Atlantic.

Sperm Whales have stranded in several parts of eastern Canada, throughout the year (Table 1). Dead Sperm Whales are reported in the Gulf of St. Lawrence more often than might be expected judging by the infrequency of sightings. For example, between 1982 and 1985 Sperm Whales represented close to 4 percent of the total documented cetacean mortalities in the Gulf (Béland et al. 1987).

The fishery for Sperm Whales off Nova Scotia only took males (Mitchell 1975), and recent studies of living Sperm Whales on and near the Scotian Shelf have focused almost entirely on males (Mullins, Whitehead, and Weilgart 1988; Whitehead, Brennan, and Grover 1992). Recent strandings off eastern Canada have also been principally of males (Table 1). However, a female stranded in July 1994 in southern Nova Scotia (Table 1), and groups of females have twice been observed in the Gully: once on 23 June 1990 (Whitehead, Brennan and Grover 1992), and once (tentative identification) on 15 July 1993 (H. Whitehead, unpublished data). Thus, in the Atlantic, the southern limit of the Canadian EEZ appears to coincide approximately with the northern limit of the range of female Sperm Whales (Figure 1).

A male tagged off Nova Scotia ($42^{\circ} 12' \text{N}$, $65^{\circ} 07' \text{W}$; 26 July 1966) was taken by whalers off northwestern Spain ($44^{\circ} 10' \text{N}$, $11^{\circ} 20' \text{W}$; 7 August 1973), some 6000 km away (Mitchell 1975).

Another male taken in the northern part of Denmark Strait (ca. 65°N , $29^{\circ} 45' \text{W}$) in early August 1981 apparently had been wounded the previous August by whalers near the Azores about 3000 km to the south (Martin 1982; Sigurjónsson 1985). Several Azorean-type hand harpoons (or harpoon fragments) were found in Sperm Whales killed off northwestern Spain (Aguilar 1985). Thus Sperm Whales move across large parts of the North Atlantic, and the International Whaling Commission has accordingly managed whaling for Sperm Whales in the North Atlantic on the assumption that there is only one population.

However, the equator does not act as a barrier to Sperm Whale movements, so that distinguishing North Atlantic versus South Atlantic populations is artificial. A young male tagged off Mauritania, West Africa, in late November one year was killed west of Cape Town, South Africa, in March somewhat more than four years later (Ivashin 1967). This animal had moved between an area near the Tropic of Cancer to an area far south of the Tropic of Capricorn.

North Pacific

Sperm Whales are found throughout the North Pacific, including the deeper waters of the Bering Sea, the South China Sea, the East China Sea, the Sea of Japan, the Sea of Okhotsk, the Gulf of Alaska

and the Gulf of California (Rice 1989). Females and young males generally do not move north of the Transitional Domain, just north of the Subarctic Boundary (ca. 42°N in most of the North Pacific) [Rice 1989]. Berzin and Rovnin (1966) gave the northern boundary for the summer range of females and young males in the eastern North Pacific as the southern Gulf of Alaska, approximately in the latitude of 50–51°N. The occasional occurrence of females as far north as the Aleutian Islands may be explained by exceptional incursions of warm water into high latitudes (Pike and MacAskie 1969).

Sperm Whales are present in the deep waters off the west coast of Canada (Figure 1), and strandings have been reported at a low, but quite steady, rate (Table 1). The whaling grounds for Sperm Whales off Vancouver Island were in the open ocean up to 200 nautical miles (370 km) from shore. Large concentrations, including herds of 50 to 150 animals, were encountered there from late spring through early autumn (Pike and MacAskie 1969). Sperm Whales are observed occasionally in Hecate Strait, Dixon Entrance, Queen Charlotte Sound, and the broader inside waterways north of Vancouver Island (Pike and MacAskie 1969; H. Patterson, Marine Mammal Research Group, Box 6244, Victoria, B.C. V8P 5L5; personal communication).

Ninety percent of the Sperm Whales taken in British Columbia were males averaging 11.6–14.0 m long, and most of them were sexually mature (Pike and MacAskie 1969). This strong bias in the catch could have been at least partially due to legal restrictions, including requirements that only whales 35 ft (10.7 m) or longer be hunted and that females accompanied by calves not be taken. Females and young are present in the deep waters off Vancouver Island (Pike and MacAskie 1969) and, in some years, the Queen Charlotte Islands (Reeves et al. 1985).

Tagged Sperm Whales have crossed much of the North Pacific, as well as from the North Pacific to the South Pacific (Kasuya and Miyashita 1988). Despite this, there has been considerable inconclusive debate as to whether the Sperm Whales in the North Pacific constitute one, two, three or more stocks (e.g., Rice 1974; Bannister and Mitchell 1980; International Whaling Commission 1980; Kasuya and Miyashita 1988; Donovan 1991).

Exploitation and Protection

North Atlantic

Sperm Whales were hunted by American and European whalers on many grounds throughout the North Atlantic, beginning in the early 1700s (Starbuck 1878). The 18th and 19th Century hunting grounds of the American whaling fleet included the Labrador and Newfoundland coasts, the Gulf of St. Lawrence, and the Grand Banks.

Modern whaling began in the 1860s. Although rorquals were the principal targets of most modern whaling operations in the North Atlantic, substantial catches of Sperm Whales (100 or more per year) were made in Iceland (mid-1950s to 1982), Madeira (to 1981), the Azores (to 1987), and Spain (early 1950s to 1980), and moderate but regular catches were made in Norway, the Faroe Islands, Portugal, and Canada (Jonsgård 1977). Small numbers of Sperm Whales continued to be taken in the Lesser Antilles as recently as the 1980s (Price 1985; Reeves 1988).

Whalers in Newfoundland and Labrador caught from 0 to 53 Sperm Whales per year (mean 6/yr) from 1904 to 1970 (Mitchell 1974). Sperm Whales did not become major targets of shore whaling in Nova Scotia until 1970, when 25 were taken (Mitchell 1974). From 1964, when operations began at Blandford, through 1972, when commercial whaling in Canada stopped, the total Nova Scotian catch of Sperm Whales was 109 males and no females (Mitchell 1975). Sperm Whales generally were taken at Blandford only when Fin Whales (*Balaenoptera physalus*) and Sei Whales (*Balaenoptera borealis*) were unavailable, due either to their absence on the grounds or to the fact that quotas had been filled (Mitchell 1975).

There was no Sperm Whale catch limit in the North Atlantic until 1977, when the International Whaling Commission set a quota of 685 whales per year (Sigurjónsson 1988). In 1980 the quota was reduced to 273, divided by bilateral agreement between Spain (173) and Iceland (100) and in 1981 it was further reduced to 130 (Iceland only; Spain ceased whaling). The Sperm Whales in the North Atlantic were classified as a protected stock beginning in 1982. Catching at Madeira and the Azores was unaffected by the regulations because Portugal was not a member of the International Whaling Commission.

Currently (1996) we are unaware of any directed catch of Sperm Whales in the North Atlantic.

North Pacific

The American and European pelagic whaling fleets began visiting Sperm Whale grounds in the Pacific Ocean in the late 1700s (Starbuck 1878). Thereafter, tens of thousands of Sperm Whales were taken in the North Pacific by the American, French, and British fleets (du Pasquier 1982; Best 1983; Webb 1988). The open-boat fishery in the North Pacific was especially intense between about 1825 and 1845 (Tillman and Breiwick 1983).

Modern whaling was introduced to the North Pacific in the last decade of the 1800s, and floating factories and shore stations proliferated during the early decades of the 20th Century (Ohsumi 1980). A list of reported Sperm Whale catches throughout the

TABLE 1. Known strandings of Sperm Whales on Canadian coasts, including dead animals discovered at sea, during 1987 to 1995 (Q.C.I. = Queen Charlotte Islands; P.E.I. = Prince Edward Island) from R. Baird and H. Patterson (Marine Mammal Research Group, Box 6244, Victoria, British Columbia), P.-Y. Daoust (University of Prince Edward Island Veterinary College), M. Dillon (Department of Biology, Dalhousie University, Halifax, Nova Scotia), Z. Lucas (P.O. Box 3504, South Halifax, Nova Scotia), S. Todd (Whale Research Group, Memorial University of Newfoundland), R. Michaud (GREMM, Tadoussac, Quebec), and D. McAlpine (New Brunswick Museum, Saint John, New Brunswick).

Date	Position	No.	Length (m)	Sex	Comments
Newfoundland/Labrador					
11 June 1987	Red Harbour, Placentia Bay	1	15	♂	Dead
8 July 1987	Penguin Island West, South Coast	1	13	♂	Dead
1 March 1987	Conception Harbor, Conception Bay	1	?	?	
30 September 1990	Black Tickle, Labrador	4	?	?	Entered harbour, driven out
15 January 1991	Port aux Choix, West Coast	1	?	?	Dead
6 March 1995	Lord's Cove, Burin Peninsula	1	15	♂	Dead
Nova Scotia					
6 October 1990	Sable Island	2	?	♂	Dead
			13.8	♂	Dead
25 April 1991	Isle Petitgras, Cape Breton Island	2	14.5	♂	Dead
			11.6	♂	
– January 1992	Sable Island	3	?	♂	Dead
– July 1994	Cherry Hill, S. Shore	1	9.8	♀	Dead
– December 1994	River John, N. Coast	1	?	?	Dead
Prince Edward Island					
13 December 1988	Near Nail Pond, N.W.	1	12.8	?	Dead, may have beached alive
1 October 1989	Covehead Harbour, N.	6			Live stranding:
			13.6	♂	died on site, 5 pulled to open
					water: 1 died and sank
5 October 1989	Malpeque Bay, N.	1	11.4	♂	Dead, probably from Cove-
					head stranding, 45 km away
6 October 1989	N.W. of Malpeque	1	?	?	Dead, at sea, probably from
					Covehead stranding
19 December 1991	North Rustico, N.	1	?	♂	
20 December 1991	Brackley Beach, N.	1	12.1	♂	Dead
23 December 1991	Brackley Beach	1	13.1	♂	Dead
New Brunswick					
No strandings since 1987, although some dead animals from Covehead, Prince Edward Island strandings washed ashore in northern New Brunswick.					
Quebec					
13 June 1992	Port Meunier, Anticosti Island	1	13.5	♂	Dead
24 June 1992	Sheldrake 50°15'N, 64°54'W	1	10.7	♂	Dead
British Columbia					
26 June 1988	Goose Island 51°58'N, 128°26'W	1	?	?	Dead
6 December 1988	Rose Pit, Queen Charlotte Islands	1	?	?	Dead
	54°10', 131°40'				
17 November 1990	98 nm W of Tofino 49°04'N, 128°27'W	1	?	♂?	Dead
7 December 1990	Tsusiatic Falls 48°42'N, 124°56'W	1	12.5	♂?	Dead
22 May 1991	Benson Pt, Nootka Island	1	5.5	♀	Dead
	49°47'N, 126°53'W				
2 November 1991	Graham Island 53°23'N, 133°11'W	1	10	♂	Dead
15 January 1993	White Point, Graham Island	1	?	?	Dead
1 February 1994	Hecate Strait	1	?	?	Dead

North Pacific from 1910 to 1976 totals more than a quarter million, of which nearly 60 percent were taken between 1963 and 1976 (Ohsumi 1980). Large post-war catches were made from shore stations in Japan and the Kuril Islands and by Japanese and Soviet floating factories that operated all over the North Pacific (Ohsumi 1980; Kasuya 1991).

Shore-based whaling for Sperm Whales off western North America has a long history. Sperm Whales were prominent in the catches of stations on Vancouver Island and the Queen Charlotte Islands (Pike and MacAskie 1969; minimum of 5937 taken from 1919 through 1967), Kodiak and the Aleutian Islands (Reeves et al. 1985), Washington State

(Scheffer and Slipp 1948), and California (Rice 1974). Shore whaling ended on the Canadian west coast in 1967 and on the west coast of the United States in 1971 (Ohsumi 1980).

A North Pacific Working Group was established by the International Whaling Commission in 1951 and a Sperm Whale Subcommittee of the Scientific Committee of the International Whaling Commission in 1962. Based largely on the work of these groups, the Commission began setting Sperm Whale quotas for pelagic whaling in the North Pacific in 1971. The quota was subdivided by sex beginning in 1973. In 1975 North Pacific catch limits were 6000 males and 4000 females (International Whaling Commission 1977), and, in 1981, 890 males and 0 females (International Whaling Commission 1982a). The Japanese officially stopped catching Sperm Whales in the North Pacific in 1988.

Worldwide

A worldwide ban on commercial whaling was agreed by the International Whaling Commission in 1982 and took effect in 1985. By the end of the 1980s the few remaining major shore-based whaling operations involving a catch of Sperm Whales (Iceland, the Azores, Madeira and Japan) had ceased. The Sperm Whale has been in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) since 1985. Trade in products, most importantly sperm oil, teeth, and ambergris (a waxy substance found in the large intestine of the Sperm Whale) is therefore illegal in most countries (but not Japan and Norway, both of which entered reservations against the Appendix I listing). Since 1981, importation of sperm oil and other Sperm Whale products (teeth excepted) has been prohibited by the European Union, and this has meant the closing of a formerly important market (Klinowska 1991). The importation of marine mammal products has been banned in the United States since 1972.

The only place in the world where a catch of Sperm Whales is known to continue is at Lamalera, Lembata (Lomblem on world maps), Indonesia, where a few animals are taken per year by primitive methods (Barnes 1991).

Population Sizes and Trends

All available estimates of Sperm Whale population sizes are problematic. To obtain unbiased population estimates, visual counts from ships or aircraft must be corrected to account for their dives which generally last at least 30 min (Papastavrou, Smith, and Whitehead 1989; Watkins et al. 1993). Reliable corrections for Sperm Whale dives are not available, and estimates from visual counts are presented uncorrected and so have a negative bias. Thus, sever-

al well-conducted visual surveys provide useful minimum density estimates for particular ocean areas (e.g.; Christensen, Haug, and Øien 1992; Wade and Gerrodette 1993; Davis et al. 1995). Estimates from visual surveys off North America include 756 (CV 0.49) from ship surveys off California (Barlow 1995), 892 (CV 0.99) from aerial surveys off California (Forney, Barlow, and Carretta 1995), and 337 (CV 0.50) from aerial surveys of the continental shelf and slope waters off the northeastern United States (Blaylock et al. 1995).

Acoustic surveys of Sperm Whales, in which a count is made of the number of vocalizations or vocalizing animals heard through towed hydrophones, have been attempted (e.g.; Leaper, Chappell, and Gordon 1992; Davis et al. 1995), but the methodology behind such censuses need further development. In two cases mark-recapture estimates of the number of animals visiting a restricted study area have been made using individual photographic identifications (Whitehead, Waters, and Lyrholm 1992; Childerhouse, Dawson, and Slooten 1995). However, the wide ranging behaviour of this species, and the lack of any clear stock divisions, means that neither of these estimates refer to a discrete population.

During the 1970s and early 1980s, considerable effort was put into trying to determine the status of Sperm Whale populations using data obtained during whaling, principally catch per unit effort statistics and changes in length and age distributions. There are many problems with these estimates, including the lack of clear stock divisions and the differences in distribution and ranging behaviour of the different segments of the population, with the result that none of these estimates of the sizes of Sperm Whale populations are credible (Cooke 1986).

A fundamental problem when trying to assess the status of Sperm Whale populations is determining the effects of the open-boat hunt, which principally took place in the 19th Century (Gambell 1983). Using analyses of whalers' logbooks, Whitehead (1995) estimated that Pacific Sperm Whale populations may have been reduced to about 10 to 30% of their pre-whaling size by 1860. Only slight recovery was probably achieved by 1946, when modern whaling for Sperm Whales became intense. As Sperm Whaling started earlier in the Atlantic (see above), the Atlantic populations may have been more seriously affected than those in the Pacific (Whitehead 1995).

It is generally agreed that modern commercial whaling made further substantial reductions in the populations of adult male Sperm Whales in all oceans (Gosho, Rice, and Breiwick 1984). Populations of adult females were also reduced, but less severely in most cases (Gosho, Rice, and Breiwick 1984).

In the North Atlantic, catch-effort series from Spain indicate that the hunted population of males was reduced by approximately 80% between 1905 and 1981; that of females by about 50% (Gosho, Rice, and Breiwick 1984). Data from Iceland and the Azores, used in a length-specific model, indicate similar but less extreme declines in those areas during the same time-interval (Gosho, Rice, and Breiwick 1984: their Table 5).

Models of North Pacific Sperm Whale populations suggest pre-whaling numbers of a few hundred thousand, with modern whaling depleting male numbers by about 36% and females by 14% (Gosho, Rice, and Breiwick 1984). However, as noted above, these estimates have little credibility. There is an additional problem in that the Soviets, who were important exploiters of North Pacific Sperm Whales, seriously misreported catches (Yablokov 1994). This was not public knowledge when the status of North Pacific Sperm Whale populations was examined in the late 1970s and early 1980s.

Estimates of Sperm Whale numbers from surveys and photoidentifications suggest a few thousand individuals inhabiting relatively small parts of the world's oceans (e.g.; Christensen, Haug, and Øien 1992; Whitehead, Waters, and Lyrholm 1992; Wade and Gerrodette 1993) with a preliminary estimate of some 140000 for the southern oceans, south of 30°S (Butterworth and Geromont 1996). Thus, as Sperm Whales continue to be sighted over deep waters throughout the world, it seems likely that there are a few hundred thousand alive today. The relationship between their abundance now, and that in 1700, before substantial whaling began, is unknown, although males are probably depleted to a greater extent than females.

Habitat

Although Sperm Whales can be found over any deep water, they are most abundant near the edges of continental shelves, large islands and offshore banks and over submarine trenches and canyons where vertical mixing of water masses creates zones of high biological productivity (Berzin 1971; Gulland 1974; Jaquet 1996). Females are rarely found in waters less than 1000 m deep (H. Whitehead, unpublished data). Males, although also primarily deep water animals, are in some ocean areas regularly found in waters of 200 to 1000 m (Caldwell, Caldwell, and Rice 1966). A prime example of relatively shallow water habitat of male Sperm Whales is on the Scotian Shelf where they were caught, and are seen, in water depths of 40 to 200 m (Mitchell 1975; Whitehead, Brennan, and Grover 1992). In addition to their stricter habitat requirements for depth, female Sperm Whales are also generally restricted to waters with surface temperatures warmer than about 15°C (Rice 1989).

General Biology

Reproduction

Females begin to ovulate (and usually conceive for the first time) at seven to 13 years of age when they are 8.3 to 9.2 m long (Rice 1989). Intervals between births are usually about four to six years, although older females have much reduced reproductive rates (Best, Canham, and Macleod 1984). Following a gestation period of about 15 to 16 months, a single 4 m calf is born (Best, Canham, and Macleod 1984). In most areas there is a peak calving season of about three months during the spring (Best, Canham, and Macleod 1984). Lactation seems to last about two years although the duration varies, and estimates are complicated by both allosuckling – suckling by females other than the mother – and occasional suckling of older (up to 13 yr) juveniles (Best, Canham, and Macleod 1984; Gordon 1987b).

Sexual maturation in males is gradual, beginning at about seven to 11 yr of age and a length of 8.7 to 10.3 m (Rice 1989). The relative size of the testes, and density of spermatozoa, increase during the male's late 20s (Rice 1989). These physiological changes are consistent with what is known about breeding strategies in male Sperm Whales. Males in their late teens and early twenties are largely segregated from females by latitude. On the prime breeding grounds they would probably generally be out-competed by older, and much larger, males, so it pays them to remain at high latitudes, investing in growth rather than seeking mating opportunities (Whitehead 1994). However, there is some overlap in distribution, and young sexually mature males will attend females whom they encounter, and may obtain some mating opportunities (Best, Canham, and Macleod 1984; Whitehead, Brennan, and Grover 1992). Large males, in their late 20s and older, migrate back to low latitudes to breed (Best 1979). The duration, frequency and timing of such migrations are unknown.

While on the breeding grounds the large males rove between groups of females spending a few hours or so with each (Whitehead 1993). The large males do fight each other, but rarely (Best 1979; Kato 1984; Clarke, R. and Paliza 1988; Whitehead 1993). Watkins et al. (1993) suggested that males on a breeding ground may establish dominance hierarchies. This, together with synchronized oestrus among grouped females (Best and Butterworth 1980), may account for the indications of paternal relatedness among grouped females shown by genetic analysis (Richard et al. 1996). Mating itself has not been convincingly described.

Population Structure and Social Behaviour

The fundamental element of the social structure of the Sperm Whale is the matrilineal family unit: about 12 genetically related females and their offspring

who are permanent companions (Best 1979; Whitehead, Waters and Lyrholm 1991; Richard et al. 1996). Most, if not all, females seem to spend their lives with their female relatives. The number of individuals in a family unit is highly variable (Whitehead, Waters, and Lyrholm 1991). The units may travel with other units for periods of days as coordinated groups of about 20 to 25 animals (Whitehead, Waters, and Lyrholm 1991).

Within groups, it is usually difficult to distinguish particular family units, so that most descriptions of social behaviour are at the level of the group. Calves accompany different adult members of their group during their mothers' dives, and groups containing calves have more staggered dives than those without, suggesting active babysitting (Gordon 1987b; Whitehead 1996a). This form of alloparental care would be in addition to allosuckling (see above), and might be the most important function of the family units and groups (Best 1979; Whitehead 1996a). Sperm Whale calves are vulnerable to predators, such as Killer Whales, but can be successfully defended by coordinated actions of members of their group (Arnbom et al. 1987; Jefferson, Stacey and Baird 1991).

The cohesive nature of the female society is also shown by the structured ranks, about 500 m long and arranged perpendicular to the direction of movement, that groups may form while foraging (Whitehead 1989), and social gatherings at the surface. For periods of several hours, members of a group may remain at or close to the surface (Figure 2), lying close to one another, often almost motionless (Whitehead and Weilgart 1991). Particular behaviour, such as rolling and touching, breaches (see front cover) and vocalizations, such as codas (see below), are characteristic of such social periods (Whitehead and Weilgart 1991).

The age at which males leave the family units seems to be highly variable but may average about six years (Best 1979; Richard et al. 1996). After dispersal the males are found in bachelor schools with other males of about their own age (Best 1979). As the males age, they generally live in smaller schools and at higher latitudes (Best 1979).

The structure of schools of young bachelors has been little studied. However, by the time males reach the age of about 20 yr, bachelor schools seem to consist of little more than loose aggregations of similar-sized whales, probably in the same area because of food concentrations (Whitehead, Brennan and Grover 1992; Childerhouse, Dawson and Slooten 1995). Such males rarely cluster close together. While an underlying social structure may exist, and is perhaps indicated by multiple strandings of males of about this age (e.g. Table 1), there is little sign of it over the spatial and temporal scales used in recent boat-based studies of living animals (Whitehead, Brennan, and Grover 1992; Childerhouse, Dawson,

and Slooten 1995). The largest males appear essentially solitary, and some evidence suggests that they avoid one another on the breeding grounds (Whitehead 1993).

Aggregations of 50 to as many as several hundred Sperm Whales are sometimes encountered (Caldwell, Caldwell, and Rice 1966; Whitehead and Weilgart 1990). These are temporary gatherings, probably formed in response to clumped prey.

Diving

A typical Sperm Whale dive cycle consists of a dive to roughly 400 m below the surface for about 40 min followed by breathing at the surface for about 8 min, with the whale maintaining a speed of approximately 4 km/hr throughout (Gordon 1987a; Papastavrou, Smith and Whitehead 1989; Whitehead, Brennan, and Grover 1992; Watkins et al. 1993). However, there is considerable variation. The longest timed dive was well over two hours (Watkins, Moore, and Tyack 1985), and the discovery of a fresh bottom-dwelling shark in the stomach of a Sperm Whale captured in over 3195 m of water, as well as other data, suggests that the species is capable of dives of several kilometres (Clarke 1976).

Feeding

Sperm Whales prey mainly on mesopelagic and bathypelagic cephalopods of more than 55 species from 36 genera (Kawakami 1980). Most of these squid are quite small, weighing a few hundred grams (Clarke, Martins, and Pascoe 1993). However, they do take much larger animals at times including the Giant Squid (*Architeuthis* sp.) which can approach the size of the Sperm Whales themselves (Fiscus and Rice 1974). Large males prey on larger species of cephalopod and on larger individuals of a given species than do females and younger males (Best 1979; Clarke 1980; Best, Canham, and Macleod 1984). A variety of large demersal and mesopelagic fishes is also taken, especially by adult males in high latitudes, for example in Denmark Strait (Kawakami 1980; Martin and Clarke 1986). Items occasionally found in Sperm Whale stomachs include large crustaceans, parts of seals, stones, and man-made flotsam and jetsam (Rice 1989). However, there is no evidence that Sperm Whales prey on mammals regularly. Most stomachs examined from Sperm Whales taken off Vancouver Island during late spring, summer, and fall contained food, mainly squid (*Moroteuthis robusta* and *Gonatus* sp.), Ragfish (*Acrotus willoughbyi*) and Rockfish (*Sebastes* sp.) [Pike and MacAskie 1969].

Clarke, Martins, and Pascoe (1993) suggested that the cephalopod prey of Sperm Whales fall into two main classes. Smaller, neutrally buoyant, luminous animals without much musculature are easily detected visually and captured; whereas larger, faster, non-

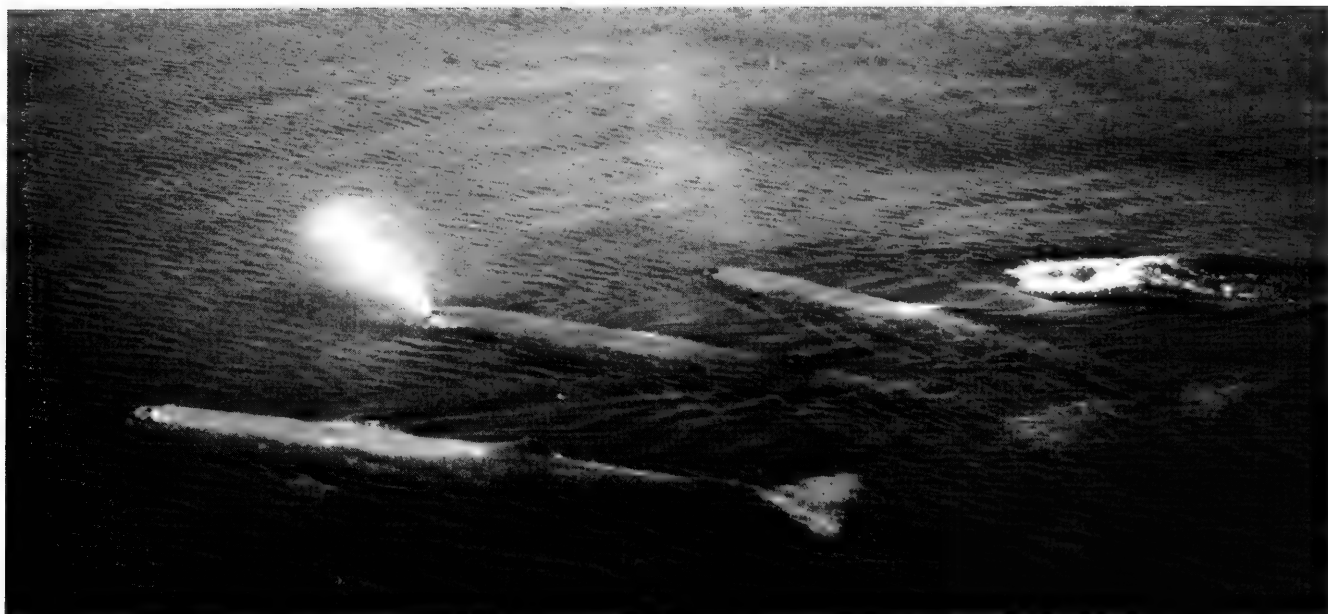


FIGURE 2. Grouped Sperm Whales at surface, Galápagos Islands, 1985.

luminescent animals must be actively chased using sonar (see below).

Sperm Whales apparently feed at all times of day, year-round (Rice 1989). Lockyer (1981) developed an energy budget for Sperm Whales. She concluded, judging mainly from an analysis of stomach capacities and assuming a diet of squid providing 800 kcal/kg, that Sperm Whales weighing less than 15 metric tons consume about 3 percent of their body mass daily. This rate probably increases to about 3.5 percent for the 30- to 50-ton males.

Acoustics

The principal vocalization of the Sperm Whale is a loud (source level 171dB re 1 μ Pa), broad-band (ca. 0.1 to 20kHz) click (Worthington and Schevill 1957; Backus and Schevill 1966; Watkins 1980; Weilgart 1990; Goold and Jones 1995). These clicks are used in a number of ways.

During deep foraging dives, the clicks are heard in long trains with inter-click intervals of about 0.8 s for males and 0.5 s for females (Mullins, Whitehead, and Weilgart 1988; Whitehead and Weilgart 1990; Goold and Jones 1995). Most authors (e.g., Norris and Harvey 1972; Gordon 1987a; Weilgart 1990; Goold and Jones 1995) believe that these clicks are a form of echolocation, allowing the whales to detect prey at ranges of several hundred metres.

During social periods Sperm Whales produce codas, consisting of from two to about 20 clicks arranged into a patterned series (Watkins and Schevill 1977). Codas are often heard as exchanges, and they seem to function as communication (Watkins and Schevill 1977; Weilgart and Whitehead 1993).

Other click-based vocalizations include creaks (click trains with high repetition rates) heard during

both foraging and social periods (Gordon 1987a; Whitehead and Weilgart 1991), and slow clicks: loud, reverberant clicks with an inter-click interval of about 6 s heard principally from mature males on the breeding grounds (Weilgart and Whitehead 1988). A few, much quieter, non-click vocalizations are occasionally recorded from Sperm Whales (Gordon 1987a).

Limiting Factors

Mortality

Estimates of total natural mortality rates for Sperm Whales vary between 0.05 and 0.09 per year (Rice 1989). Young Sperm Whales are preyed upon by Killer Whales and possibly by large sharks (Best, Canham, and Macleod 1984; Arnborn et al. 1987), but adult Sperm Whales probably experience almost no natural predation (Jefferson, Stacey, and Baird 1991). Lambertsen (*in* International Whaling Commission 1987) suggested that nematodes can inflict penetrating ulcers in the stomachs of Sperm Whales, in rare instances possibly causing death.

Sperm Whales strand, singly or multiply (up to 72 animals), alive or dead throughout the world from time to time (Rice 1989; Table 1). The causes of the strandings are generally unclear.

During 1988 and 1989 at least 32 dead male Sperm Whales were discovered in northern Europe, about as many as the total reported from the area during the previous 100 years (Christensen 1990). In late 1994, another 20 Sperm Whales were found dead in and around the North Sea. It is not clear what caused these deaths, although pollutants might have contributed to the rash of deaths in what is one of the more polluted parts of the world's oceans (Joiris 1995). In general, Sperm Whales have pollutant

loads somewhere between those of the often highly contaminated inshore odontocetes, and the much less affected baleen whales (Aguilar 1983).

Some mortality is caused by entanglement in gill-nets (Notarbartolo di Sciara 1990; Barlow et al. 1994; IWC 1994) and other fishing gear (Haase and Félix 1994). Ingestion of marine debris such as plastic buckets and netting could pose serious health risks to individuals (IWC 1987). Sperm Whales may be killed or injured by collisions with ships. A severely injured, but living, Sperm Whale observed south of Nova Scotia on 10 May 1994, in position 42°12'N, 65°21'W (J. Conway, Department of Fisheries and Oceans, Maritime Region, Halifax, Nova Scotia; personal communication), was likely hit by a ship.

Disturbance

Sperm Whales seem to be particularly sensitive to acoustic disturbances within the frequency range of their own clicks. They consistently interrupted their sound production in the presence of underwater pulses made by pingers or submarine sonar (Watkins and Schevill 1975; Watkins, Moore, and Tyack 1985), and deserted an area of abundance after the onset of seismic testing with air guns (Davis et al. 1995: 244-249). Sperm Whales sometimes react to close approaches (<200 m) of a survey vessel by abrupt dives (Davis et al. 1995: 232-233). High-speed whalewatching vessels affected the behaviour of male Sperm Whales off Kaikoura, New Zealand, especially when the boats were not handled cautiously (Gordon et al. 1992).

Climatic/Oceanographic Factors

Off the Galápagos Islands, Sperm Whales have greatly reduced feeding success when sea temperatures are warmer than average, as in El Niño years (Whitehead, Papastavrou, and Smith 1989). In such conditions, their residence periods near the Islands are shorter, and their movements more directed (Whitehead 1996b). If these effects are general, then global warming could have a serious impact on Sperm Whale populations.

Residual Effects of Whaling

We do not know how populations of Sperm Whales have been affected by past whaling. However there is concern that the effects may persist longer than would normally be expected for an exploited population.

The social organization and segregation of the sexes of this species have led to a consideration of the possibility that a reduction in the ratio of socially mature males to females, caused by selective whaling for bulls, could result in a decrease in the rate of conception of females (e.g., Mitchell 1977; IWC 1980; May and Beddington 1980; Whitehead 1987). There is evidence that this happened in the southeast Pacific (Clarke, Aguayo, and Paliza 1980). A particularly

low calving rate off the Galápagos Islands during the past ten years may be related to the small number of mature males in the area (Whitehead 1990). The Galápagos are close to the Peruvian whaling grounds where males were especially heavily hunted in the 1970s and early 1980s (Ramírez 1989).

Special Significance of the Species

A crude guess at the total amount of cephalopods consumed annually by the world Sperm Whale population is 110 to 320 million metric tons (Clarke 1977), roughly comparable with the total world-wide catch of all marine species. A high proportion of the Sperm Whale's diet consists of ammoniacal squid that are unacceptable as human food. Moreover, the direct harvesting by humans of most of the Sperm Whale's prey species is probably impractical. As primarily a mesopelagic macroteuthophage, the Sperm Whale probably has little direct competition for food resources from other marine mammals or humans. Its closest cetacean competitors are ziphiid whales that feed in the same depth zones but generally prey on smaller squids (Rice 1989). Non-cetacean potential competitors for food are Elephant Seals (*Mirounga* spp.) and some of the larger squids (e.g., *Dosidicus gigas*) that are themselves preyed upon by Sperm Whales.

Although the meat of Sperm Whales is not considered palatable in much of the world (Berzin 1971), it is eaten in parts of Japan (Freeman 1988), eastern Indonesia (Barnes 1991), and the Lesser Antilles (Price 1985), despite warnings that it may contain unsafe amounts of organic mercury (Beary 1979). Other valuable products obtained from Sperm Whales include: spermaceti, a waxy substance from the whale's head that has been widely used to make candles and cosmetics (e.g., cold creams); sperm oil, used as a temperature- and pressure-resistant lubricant and industrial wax; ambergris, a concretion formed in the large intestine of the Sperm Whale, used as a fixative in perfumes; and ivory teeth, used for carving (Berzin 1971). Sperm oil was generally more valuable than that obtained from mysticete whales because of its alcohol content; the alcohols were used for manufacturing many kinds of detergent (Bailey, Carter, and Swain 1952). Sperm Whale liver is rich in vitamin A (Bailey, Carter, and Swain 1952). Synthetic or natural substitutes are now available for most Sperm Whale products.

Since 1988, watching living Sperm Whales has become an important activity in a few parts of the world. The most successful operation is in Kaikoura, New Zealand, but whale-watch tours primarily directed at Sperm Whales are also run regularly from Dominica in the West Indies, Andenes in Norway, the Azores, and Japan (Hoyt 1995). In other parts of the world, including the Galápagos and Antarctica, Sperm Whales are among the attractions of more

general nature-tourism operations. A number of other sites with deep water close to shore, including Sri Lanka and some Caribbean islands, have considerable potential for the development of whale-watching based on Sperm Whales (Hoyt 1995). Canada, with its broad continental shelves keeping the Sperm Whales generally away from the coasts, appears to have little potential for whale-watching based principally on Sperm Whales. However, in the last few years the Sperm Whales appearing off Tadoussac, Quebec (see above), have been an attractive but sporadic target of the local whale-watching tour operators, who focus mainly on rorquals (Michaud, personal communication).

The Sperm Whale is a creature of extremes. It has the largest brain on Earth and (probably) the most powerful natural sonar system, as well as the greatest geographical separation of the sexes. In their sexual dimorphism, dispersion, biomass, diving ability, and longevity Sperm Whales are at, or close to, the maxima of all mammals. No animal on Earth is much like the Sperm Whale anatomically or ecologically, and its unusual social system is only paralleled closely among the elephants (Weilgart, Whitehead, and Payne 1996). Combinations of these and other attributes have given the Sperm Whale particular significance in a range of areas of human activity, including aboriginal cultures [such as the New Zealand Maoris (Anonymous 1996)], commerce (Starbuck 1878) and literature (Melville 1851).

Evaluation

Sperm Whale populations were likely well below pre-whaling levels in 1946 when modern whaling for them became especially intense, were reduced substantially between 1950 and 1980 (see above), and can only recover very slowly (see below). Thus the current world population is certainly much smaller than it was before the start of whaling for Sperm Whales in about 1710. However, recent abundance estimates and sighting rates in different ocean areas suggest a world population of more than 100 000 (see above).

Whatever the current level, it will not rise fast. The most recent estimates of Sperm Whale population parameters by the Scientific Committee of the International Whaling Commission (IWC 1982b) suggest a maximal rate of increase of about 0.9% per year. Residual effects of whaling (see above), and other factors, may slow even this low rate, leading to very long recovery times.

The lack of any clear stock structure means that the effects of human disturbance, whether from whaling or pollution or other sources, will not be contained within a clearly defined subset of the aggregate population. However, this attribute also promotes resilience at smaller spatial scales: if Sperm Whales are removed from an area, but the

world population is healthy, then it is likely that recolonization will take place before too long.

Probably the greatest current threat to Sperm Whale populations is chemical pollution. If toxic loads continue to accumulate in their prey, so that levels in individual animals rise, and this affects reproduction, mortality or social behaviour, then a putative population increase of less than 1% per year could easily become a population decrease. Acoustic pollution could be an additional detrimental factor. The bycatch of Sperm Whales in fishing gear is substantial and regular in some areas. This means that the species is being "exploited", indirectly, in many more areas and at a greater scale than suggested by catch statistics alone. As whaling for Sperm Whales has declined, the use of fishing gear that is hazardous for cetaceans, especially gillnets, has expanded (IWC 1994). A third area of threat to Sperm Whale populations is the possibility of breakdown in the current international framework for the management and protection of whale populations (through the International Whaling Commission) and resultant widespread, unregulated whaling.

Considering the enormous range of the species, its aggregate numerical abundance, and its virtually complete protection from commercial exploitation at present, the Sperm Whale is not endangered. Although vulnerable (principally because of its very slow potential rate of increase which could easily be reversed) and threatened by pollution and other factors, the threats are probably not sufficiently immediate or clear that a COSEWIC designation would be appropriate or useful at this time. If large-scale commercial whaling should resume, or trends of increased pollutant levels or mortality become apparent, then the status of the Sperm Whale should be re-evaluated by COSEWIC.

Canada would improve the prospects of the Sperm Whale, as well as other marine life, by any actions which reduce marine pollution or support international agreements regulating the exploitation of marine resources, such as the International Whaling Commission.

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Notes

First Breeding Record of Red-breasted Merganser, *Mergus serrator*, on Axel Heiberg Island, Northwest Territories

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A female Red-breasted Merganser with six young was observed on the river flowing from Buchanan Lake into Mokka Fjord on Axel Heiberg Island, Northwest Territories, on 9 August 1993. This is some 900 km north of the northern edge of the known breeding range in eastern Canada for this species.

Key Words: Red-breasted Merganser, *Mergus serrator*, breeding record, Axel Heiberg Island, Northwest Territories.

The Red-breasted Merganser (*Mergus serrator*) breeds extensively throughout the boreal regions of Canada. The northern limit of its general breeding range extends from about 67°N on Baffin Island through 65°N in western Hudson Bay to 70°N in the western Arctic (Godfrey 1986). In addition, breeding has been recorded on Utuk Lake (72°30'N) (Godfrey 1986) and on two occasions near Pond Inlet, 72°25'N (Renaud et al. 1981) and sightings of single birds have been made in the northern part of Baffin Island at Oliver Sound, 72°N, 78°W, and Arctic Bay 73°N, 85°W (Godfrey 1986). In Alaska the northernmost breeding sites are near Wainwright, 70°N, 160°W (Bellrose 1976). On the west coast of Greenland the known breeding range extends to about 74°N (Bellrose 1976). Also in Greenland, a female Red-breasted Merganser was seen on 2 July 1979 at Constable Bugt (84°N, 32°W), near the most northerly point of land in the world (Hjort 1982). In Europe the breeding range extends to Nord Kapp (71°N, 25°E) on Magerøya, the northernmost island of Norway (Harrison 1982; Flint et al. 1984) and in European Russia to the northwest corner of the South Island of Novaya Zemlya at 74°N, 54°E. In Asian Russia the northernmost breeding area is in the Taymyr area around 75°N, 105°W (Flint et al. 1984).

On 9 August 1993, we saw a female Red-breasted Merganser with six young, estimated age 15 and 25 days, at Mokka Fjord (79°30.0'N, 87°23.9'W) on Axel Heiberg Island, Northwest Territories, near the outlet of the river flowing from Buchanan Lake into the fjord. The habitat at Mokka Fjord consisted mainly of shingle with scattered tundra vegetation.

The riverbed, flood plain and edges of the river were largely devoid of vegetation. This agrees well with the general habitat for Red-breasted Merganser in the Arctic described by Snyder (1957). This breeding record of Red-breasted Merganser seems to be the most northerly record reported. Furthermore, as a sighting it is the second most northerly one in the world after the sighting of a single female at the north end of Greenland (Hjort 1982).

What are the chances that the ducklings were able to leave the area before freeze-up? Based on the estimated age of the brood and a fledging period of at least 59 days (Gooders and Boyer 1986), we predict a fledging date around mid-September. At that time freeze-up of freshwater lakes and rivers would normally have begun because average maximum and minimum daily temperatures in the area are well below 0°C (Anonymous 1984). Thus, to be successful, the brood would have had to move out of the lake and river system into the marine waters of Mokka Fjord well before this time. This is plausible because Red-breasted Mergansers are the most marine of the merganser ducks and are known to move their broods from freshwater into marine areas during chick development (A. J. Erskine, personal communication). According to the weekly ice composite charts published by Environment Canada (Anonymous 1993), ice coverage of marine waters in the area of Mokka Fjord was only 30% on 26 August 1993, 50% on 9 September 1993, stayed around 90% until 30 September 1993, and reached 100% only by 7 October 1993. This would have given the brood sufficient time to fledge and fly south before complete freeze-up.

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Sagina (Caryophyllaceae) Range Extensions in Canada:
S. japonica New to Newfoundland; *S. procumbens* New to the Northwest Territories

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Sagina japonica is reported as new to Newfoundland from St John's in 1992; *S. procumbens* is reported as new to the Northwest Territories from Yellowknife in 1994.

Key Words: *Sagina japonica*, *Sagina procumbens*, Caryophyllaceae, Newfoundland, Northwest Territories

Except for *Sagina nodosa*, with its relatively showy flowers (petals 3–4.5 mm long, about twice as long as sepals), the Canadian representatives of *Sagina* (Caryophyllaceae) are easily overlooked, weedy plants with inconspicuous flowers (petals to 2.5 mm long, shorter than but slightly surpassing the sepals). We report here Canadian range extensions of two species of this genus: *Sagina japonica* and *S. procumbens*.

Sagina japonica is an addition to the flora of Newfoundland. Collection data are: NEWFOUNDLAND: weed in downtown St. John's, Thieret 58108, 19 August 1992 (KNK, DAO). It was collected from

a crack between a sidewalk and the base of a building along Water Street. Many of the ca. 25 plants in the group were enmeshed in a mass of black threads. Nearby grew several plants of *Erucastrum gallicum* (Brassicaceae). The source of the seeds that established these urban weeds is unknown. The few Canadian occurrences of *S. japonica* were summarized by Crow (1978) as Nanaimo and Prince Rupert, British Columbia; and Ottawa, Ontario. No additional Canadian collections are known to us. Scoggan (1978) did not include the species. Crow (1978) reported the species only from Oregon in the United States; Mitchell and Tucker (1991) cited

collections of this "overlooked adventive" also from Connecticut, Massachusetts, New York, and Pennsylvania. The species is almost certainly more widespread in North America than present herbarium records indicate.

The Newfoundland vascular plant atlas (Rouleau and Lamoureux 1992) reported two species of *Sagina* (*S. nodosa* and *S. procumbens*) from that province. Two additional species — *S. caespitosa* and *S. saginoides* — were added to the flora by Hay et al. (1994). With the discovery of *S. japonica*, the genus is now represented in Newfoundland by five species.

Sagina japonica is an annual characterized by its 5-merous flowers, its dark brown tuberculate or pebbled seeds lacking a dorsal groove, and its glandular pubescent stems, pedicels, and calyces. The St. John's plants were noticeably viscous.

Sagina procumbens is an addition to the flora of the Northwest Territories. Collection data are: NORTHWEST TERRITORIES: garden weed, Yellowknife, 19 July 1994, Hils & Thieret 1504 (KNK, DAO). It was collected from the garden area planted with native species in front of the Tourist Information Bureau in Yellowknife. As with *S. japonica* in St. John's, there were about 25 individuals; their seed source, too, is unknown. In eastern Canada the species occurs in Quebec and all the Maritime Provinces; in the west, in British Columbia

(Crow 1978; Scoggan 1978). Crow (1978) recorded an Alaskan Panhandle collection that approaches the Yukon.

Sagina procumbens is a perennial spreading by offshoots and is characterized by its procumbent to ascending stems and its primarily 4-merous flowers with white-margined sepals.

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Use of Active Beaver, *Castor canadensis*, Lodges by Muskrats, *Ondatra zibethicus*, in Wyoming

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Three Muskrats (*Ondatra zibethicus*) were observed using active Beaver (*Castor canadensis*) lodges in Wyoming. Muskrats were observed carrying cut vegetation into active lodge entrances and one Muskrat was trapped in a run as it was leaving the lodge. Muskrats may use Beaver lodges in an attempt to decrease predation and alleviate extreme environmental conditions.

Key Words: Beaver, *Castor canadensis*, denning, Muskrats, *Ondatra zibethicus*, predation.

Lodge use by Beaver is common in northern climates and is thought to limit predation and alleviate extreme environmental temperatures (Buech et al. 1989). Rutherford (1964) hypothesized that predation pressure directly influences both the size and quality of dams and lodges. The average lodge has more than one plunge hole with a chamber located in the center near the water's surface for feeding, resting, or sleeping (Dieter and McCabe 1989).

Buech et al. (1989) examined lodge temperatures in Beaver of northern Minnesota and found that temperatures were within the thermoneutral zone for Beavers year-round. Microclimatic air temperatures in various Muskrat structures (lodges, burrows, and push-ups) were close to the thermoneutral zone for single, adult Muskrats (10° to 25° C) (MacArthur and Aleksyuk 1979). Other non-lodge-building mammals may use these lodges to reduce exposure to both

environmental factors and predation (Lovallo et al. 1993). Use of inactive Beaver (*Castor canadensis*) lodges has been recorded in Bobcats (*Felis rufus*) (Lovallo et al. 1993) and is thought to occur in Black Bears (*Ursus americanus*) (Ronald Grogan, 1996, Wyoming Cooperative Fish and Wildlife Research Unit, personal communication), although it has never been documented. Abandoned Beaver lodges or bank dens would certainly be attractive to semi-aquatic mammals and would be accessible to terrestrial animals if the entrance was not flooded.

During a reintroduction project in spring and fall of 1994 and 1995, we live-trapped Beavers throughout Wyoming, concentrating on small creeks and rivers. While Muskrats were frequently observed in Beaver ponds, and were incidentally trapped in snares set for Beaver on dams, on three different occasions we observed Muskrats apparently using lodges occupied by Beaver. Two Muskrats were observed swimming in and out of separate occupied Beaver lodges (NE1/4, SW1/4, Sec 20. T. 19 N. R. 78 W., Carbon County, Wyoming) and we trapped a third Muskrat at an underwater lodge entrance (NE1/4, SE1/4, Sec 20. T. 18 N. R80 W., Carbon County, Wyoming) in a snare set for Beaver. Both Muskrats observed using lodge entrances had cut vegetation in their mouths and one of them entered the lodge via a 1-m-wide canal created by Beavers. The one Muskrat trapped at the lodge entrance was dead but it appeared that it had been trapped as it was leaving the lodge. On all three occasions Beavers were live-trapped at the same entrances where Muskrats were observed or trapped, indicating that the lodges were actually used by both species.

While Muskrats typically construct huts or houses out of available vegetation (Proulx and Gilbert 1984), river dwelling Muskrats almost exclusively construct bank dens (Fuller 1951; Boutin and Birkenholz 1987). We could not determine what part of the Beaver lodge Muskrats were using. However, because Beaver are aggressive (Hill 1982) and do not tolerate invading Beaver from adjoining colonies, we suspect that Muskrats would excavate their own living quarters.

In creeks and rivers, Beaver lodges, which are more stable and long-lasting than Muskrat houses (Chamberlain 1951), could be used by Muskrats for protection from the weather and predators. Perry (1982) suggested that Muskrats would use abandoned shelters of other animals but we found no reference to this behavior in our literature review.

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Fall - Early Winter Home Ranges, Movements, and Den Use of Male Mink, *Mustela vison* in Eastern Tennessee

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Stevens, Richard T., Tom L. Ashwood, and Jonathan M. Sleeman. 1997. Fall - early winter home ranges, movements, and den use of male Mink, *Mustela vison*, in eastern Tennessee. *Canadian Field-Naturalist* 111(2): 312-314.

Three male stream-dwelling Mink (*Mustela vison*), one juvenile and two adults, were radiotracked on 97 occasions during fall and early winter in eastern Tennessee. Home range estimates ranged between 5663 m and 11083 m and average home range was the largest reported for the species. Mink made overnight movements of up to 4300 m within their home ranges, and used between 8 and 24 dens within their home ranges. Bank burrows, such as abandoned Woodchuck (*Marmota monax*) and Muskrat (*Ondatra zibethicus*) burrows and cavities within exposed tree roots, were the most often used den type (57% of dens). Male Mink home ranges and movements are potentially influenced by feeding requirements, access to females, and territoriality, but data on the extent of influence by each of these factors is limited at present.

Key Words: American Mink, *Mustela vison*, home ranges, movements, radiotelemetry, Tennessee.

Although Mink (*Mustela vison*) are found throughout most of North America north of Mexico (Linscombe et al. 1982), and are economically important furbearers (Spencer 1990), they have been the subject of relatively few ecological investigations. Radiotelemetry has been used to study Mink in Europe (Gerell 1970; Linn and Birks 1981; Dunstone and Birks 1983) and the western United States (Whitman 1981; Arnold and Fritzell 1987), but there have been no published studies of Mink home ranges and movements in eastern North America. The objective of this study was to determine the population status, home ranges, movements, and den use of Mink in eastern Tennessee.

Methods

This study was conducted along the three largest streams (East Fork Poplar Creek, Bear Creek, and White Oak Creek) originating on the U. S. Department of Energy Oak Ridge Reservation (35°56' N 84°18' W), in Oak Ridge, Tennessee. Land surrounding these streams was primarily mature Oak (*Quercus* spp.) and Hickory (*Carya* spp.) forest (Kitchings and Mann 1976).

Mink were captured with two door 15 × 15 × 61 cm or 23 × 23 × 81 cm Tomahawk live traps (Tomahawk Live Trap Co., Tomahawk, Wisconsin) using barrier tunnels (Eagle and Sergeant 1985). Captured Mink were transported to The University of Tennessee College of Veterinary Medicine in Knoxville, Tennessee. Mink were anesthetized and intraperitoneal radiotransmitters (Model #IMP/200/L, Telonics, Inc., Mesa, Arizona) were implanted under aseptic conditions. Venous blood, ectoparasite, and fecal samples were collected, sex - age class were determined (Whitman 1981), and standard mammal

body measurements were taken. All methods used in this study were approved by the Oak Ridge National Laboratory and The University of Tennessee Animal Care and Use Committees.

One daily diurnal radiolocation was obtained for each Mink using the homing technique (Mech 1983). Fixed-wing aircraft equipped with directional antennae were occasionally used when Mink could not be located from the ground. Home ranges were calculated as meters of waterway used by Mink. Because Mink typically restricted movements to narrow riparian zones (Gerell 1970; Whitman 1981), reported home ranges were linear. Typical methods of calculating home ranges as polygons would overestimate home range sizes (Whitman 1981) and would also be less ecologically meaningful. Movements were calculated as Minimum Nightly Movements (MNM), the meters of waterway between two successive diurnal locations (Arnold and Fritzell 1987). Tributaries that were not known to be utilized during the 24h period were not included in MNMs. It was not always possible to calculate MNMs, as occasionally Mink could not be located on consecutive days.

Results

Four male Mink, one juvenile and three adults, were captured in 6073 trap nights. Three of these male Mink, all captured in October or November, were successfully radiotracked.

Home ranges averaged 7519 m and ranged between 5663 m and 11038 m (Table 1). Mink often used tributaries of the main stream, and were found in tributaries in 54% of radiolocations. Tributaries contributed between 13% and 43% of total home ranges.

Overnight movements of Mink (MNM) were variable and ranged from 0 to 4300 m. The longest

TABLE 1. Home ranges (HR) of three male Mink in eastern Tennessee.

Mink	Period Radiotracked	Mass at Capture (g)	Number of Locations	Main Stream Channel in HR (m)	Tributary in HR (m)	Total HR (m)
M1	4 November 1993–26 January 1994	660	35	5109	748	5857
M3	8 October 1994–28 October 1994	900	15	3205	2458	5663
M4	2 November 1994–2 February 1995	925	47	6531	4507	11038
Mean				4948	2571	7519
Standard Error				964	1087	1786

MNM of each Mink was 1446 m, 4000 m, and 4300 m. Mink were found in the same den as the previous day in 22% to 50% of radiolocations. Mink were not monitored at night, and it was likely they left dens to forage and simply returned to the same den.

Mink used many dens within their home ranges (range = 8–24 dens). Mink used certain dens on > 1 occasion and all used certain dens for periods > 3 consecutive days. The longest consecutive period of use for a single den was 8 days. In 51–53% of radiolocations Mink were found in a previously unrecorded den. Mink most often (57% of dens) denned in bank tunnels, primarily either abandoned Muskrat (*Ondatra zibethicus*) or Woodchuck (*Marmota monax*) dens or holes between exposed tree roots. Other frequently used dens included slash piles and dense shrub entanglements (13% of dens) and culverts (8% of dens). All identified dens were within approximately 25 m of either the main stream channel or a tributary of the main stream. Most (78%) identified dens were on the stream or tributary bank, within 2 m of the water.

Discussion

Although comparisons with previously reported home ranges must be made with caution due to sample size, male Mink in this study had the largest average home range reported. Introduced male Mink were found to have an average home range of 2630 m in Sweden (Gerell 1970), and 2530 m (Dunstone and Birks 1983) and 4480 m (Linn and Birks 1981) in separate studies in Great Britain. The only radiotelemetry study of stream-dwelling Mink in North America was conducted by Whitman (1981), who reported an average home range size of 5250 m. This was smaller than our home range estimate; however, he did not include tributary movements in his estimate, and thus it may have underestimated home range size. Mink in this study had an average of 4948 m of main stream channel in their home ranges, which is similar to the results of Whitman (1981).

Home range estimates reported here were pre-breeding season home ranges. Mink begin breeding in late February or early March (Enders 1952), and the latest date a Mink was radiotracked in this study was 17 February (Table 1). Mink in Sweden (Gerell

1970), North Dakota (Eagle and Sargeant 1985), and Manitoba (Arnold and Fritzell 1987) extended their home ranges significantly during the breeding season because of movements in search of females. Therefore, if radiotracking had continued into the breeding season, home ranges may have been significantly larger.

Mink have relatively large home ranges for carnivores (Arnold and Fritzell 1987). Spacing in solitary males is thought to be an evolutionary compromise between competing demands for food and females (Sandell 1989). Other male mustelids, such as Martens (*Martes americana*), were thought to maintain relatively large home ranges to insure access to one or more females (Katnik et al. 1994). However, because Mink leave their pre-breeding season home ranges to search for females during the breeding season, home ranges during the non-breeding season should be driven primarily by feeding requirements. Gerell (1970) reported that male Mink in Sweden were territorial and that territoriality was a major determinant of home range size. Whitman (1981), however, found no evidence of territoriality in Mink in Idaho, and even found Mink of the same sex denning within meters of each other. As no two Mink inhabiting the same stream were simultaneously radiotracked in this study, no data on territoriality was collected.

Presence of suitable den sites can be an important factor in the distribution and habitat utilization of Mink (Gerell 1970; Linscombe et al. 1982). Bank tunnels, such as abandoned muskrat burrows and natural cavities among exposed tree roots were the most often used den sites in this study, as well as in previous studies by Marshall (1936), Gerell (1970), and Shladweiler and Storm (1969). Whitman (1981) reported logjams to be the most common den type in Idaho (33% of dens), but bank tunnels were also used often (30% of dens). As in this study, these previous studies found that Mink, especially males, use many different dens within their home ranges. Marshall (1936) and Melquist et al. (1981) reported that Mink choose daily den sites based on proximity to current foraging areas. Because home ranges were large, it was necessary to maintain many different dens.

There is a need for more ecological investigations of Mink in North America to elucidate factors influencing movements, habitat use, and home range sizes. Even basic aspects of Mink ecology such as territorial behavior are poorly understood, and existing data (Gerell 1970; Whitman 1981) are contradictory.

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Observations of a Possible Cleaning Symbiosis Between Painted Turtles, *Chrysemys picta*, and Snapping Turtles, *Chelydra serpentina*, in Central Ontario

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Painted Turtles (*Chrysemys picta*) were observed removing chlorophytic algae and leeches (*Placobdella* spp.) from Snapping Turtles (*Chelydra serpentina*) in a pond in central Ontario. We propose that a facultative mutualistic association exists between the two species in that the Painted Turtles derive a nutritional benefit from the leeches and algae and the Snapping Turtles benefit by having parasites removed. This may be the first reported instance of a cleaning symbiosis between species of reptiles.

Key Words: Painted Turtle, *Chrysemys picta*, Snapping Turtle, *Chelydra serpentina*, mutualism, cleaning symbiosis, leech, *Placobdella parasitica*.

The interactions between an organism and its biotic environment fall into five main categories based on how the activity affects the organism: competition, predation, parasitism, mutualism and commensalism (Begon et al. 1990). Described interactions between turtles and other vertebrate members of their ecological community tend to fall into the first three of these categories. Mutualistic and commensalistic interactions involving turtles are rarely reported and, where such interactions have been observed, they are usually categorized as the latter (Grier 1984; Begon et al. 1990), in which one species benefits and the other does not. For example, Painted Turtles (*Chrysemys picta*) have been reported to approach and climb on the carapace of Snapping Turtles (*Chelydra serpentina*) apparently to bask, but it appeared that there was no benefit to the Snapping Turtles (Legler 1956). In a similar example, Painted Turtles basked on the head of a Water Buffalo (*Syncerus caffer*) (MacGeorge 1928 in Boyer 1965). In another they basked on the nesting platform of a Common Loon (*Gavia immer*) and even on the nesting loon itself (Gelatt and Kelley 1996), but because the turtles primarily used the platform and not the loon to bask, this relationship probably does not qualify as being commensal.

In rare instances, turtles have been observed in apparently mutualistic interactions, i.e. a symbiotic interaction where both species receive a benefit, usually food (Grier 1984). For example, on two occasions a Common Grackle (*Quiscalus quiscula*) was observed removing leeches (*Placobdella parasitica*) from map turtles (*Graptemys ouachitensis*) (Vogt 1979). Vogt speculated that this interaction reduced leech infestations in some populations of Map Turtles and referred to the interaction as cleaning symbiosis, defined as a cleaner organism

feeding on ectoparasites, scales, mucus or other materials from the surface of a cooperating host (Gorlick et al. 1978; Snelson et al. 1990). Other examples in chelonians involved removal of external parasites from tortoises (Vogt 1979). In these few cases, the turtle or tortoise was the passive partner in the interaction and observations suggested that the cleaning behaviour might have been unique to one or two individuals. Here we describe observations of an apparent cleaning symbiosis between two species of turtles and discuss whether this behaviour qualifies as the first reported instance of mutualistic relationship between species of turtles.

We observed the turtles at Wolf Howl Pond in Algonquin Provincial Park, Ontario (45°34'N, 78°41'W). The pond is a 1.7-ha area of open water and floating bog mats (Schwarzkopf and Brooks 1985; Lefevre and Brooks 1995) and sustains populations of approximately 200 Painted Turtles and 5–10 Snapping Turtles. Most of these turtles are individually marked with aluminum tags and carapacial notches (Lefevre and Brooks 1995). Throughout the nesting seasons of 1995 and 1996 we observed (between 1630 and 2200h) the nesting activity of both species of turtle from an embankment bordering the east side of the pond.

During the nesting season, females of both species slowly swam up and down alongside the pond bank waiting for an opportunity to nest. Snapping Turtles nested in both early morning and evening, and the Painted Turtles nested in the late afternoon and evening. On several occasions in 1995 and 1996, male and female Painted Turtles were observed pursuing female Snapping Turtles as the latter floated or moved slowly in the water. In this relaxed position, the majority of the skin surface of the Snapping Turtle was exposed due to the

species' small plastron, and the full extension of the legs below the body and of the head forward. After approaching a Snapping Turtle, Painted Turtles investigated both the carapace, which often sustains chlorophytic algal growth, and the skin, which is commonly infested by both adults and broods of leeches (*Placobdella parasitica* and *P. ornata*) (Brooks et al. 1990). The Painted Turtles periodically explored beneath the Snapping Turtle's body and around the legs, neck and tail and were observed to remove and eat both the algae and leeches. The Snapping Turtles did not change position or appear to react during these encounters. For example, at 1934h on 14 June 1996, several Painted Turtles were observed feeding on two Snapping Turtles, and at 1910h on 18 June 1996, male Painted Turtle J6 was observed feeding on leeches on a passive Snapping Turtle. Similarly, at 2000h on 4 July 1996, Painted Turtle J46 approached female Snapping Turtle T6 and fed on leeches or algae on T6. J46 continued to follow T6 as the Snapping Turtle slowly swam beside the bank.

Painted Turtles have also been observed showing aggression towards conspecifics who approached. At 1945h on 13 June 1995, female Painted Turtle C16 attempted to climb onto the carapace of an unidentified female Snapping Turtle. When a second, unidentified Painted Turtle approached the Snapping Turtle, C16 lunged towards the other Painted Turtle, which immediately swam away. C16 subsequently swam around and under the Snapping Turtle for several minutes, and lunged twice towards a third female Painted Turtle which approached the same Snapping Turtle. This unidentified female Painted Turtle immediately swam away. C16 did not appear to bite the other Painted Turtles. Similarly, at 1910h, 21 June 1996, female Painted Turtles Y1 and A19 were observed swimming around and feeding from a passive Snapping Turtle. Y1 was then seen to lunge violently, with her mouth open, towards A19, and to snap at her. A19 immediately swam away, but returned to feed from the Snapping Turtle after Y1 had left. A19 removed leeches from the base of the tail and from the hind leg pockets of the Snapping Turtle.

These associations were observed periodically throughout the nesting seasons of 1995 and 1996. We observed Painted Turtles feeding on leeches and algae on Snapping Turtles on 10 separate occasions. Although our observations occurred during the nesting season this does not preclude occurrence of this behaviour at other times when we were not observing them as intensively.

Lake Sasajewun (45°35'N, 78°30'W) is located 20 km east of Wolf Howl Pond within Algonquin Park and is inhabited by Snapping Turtles, but not by Painted Turtles (RJB, unpublished data). As in Wolf Howl Pond, the turtles of Lake Sasajewun

have been studied intensively over the past 15 years. Captures of Snapping Turtles were made predominantly in May and June but also continued throughout July and August in both Lake Sasajewun and Wolf Howl Pond, and numbers and locations of leeches were recorded for all individuals. Using two-tailed *t*-tests we compared leech abundance within and between sites. Sample sizes were relatively small, however significantly more leeches were observed on Snapping Turtles at Lake Sasajewun in July and August than on Snapping Turtles at Wolf Howl Pond in the same interval ($t = 4.44$, $df = 2$, $P = 0.0471$). The mean number of leeches found on turtles at Sasajewun was 48, and at Wolf Howl Pond the mean was 3. We also found an increase in leech numbers between May/June and July/August at Lake Sasajewun ($t = -3.925$, $df = 3$, $P = 0.0294$), whereas a decrease occurred at Wolf Howl Pond ($t = 2.941$, $df = 27$, $P = 0.00664$). In contrast, for the Painted Turtles at Wolf Howl Pond, leeches were observed on only 13 of 113 individuals captured in May, which was not significantly different from 2 of 25 individuals captured in June ($\chi^2 = 1.23$, $df = 1$, $P > 0.25$). This indicates that a decrease in the leech population in the pond was not the reason for the decrease in leech abundance on the Snapping Turtles. Though many factors could be contributing to the different levels of parasitism by leeches, we speculate that the disappearance of leeches from *C. serpentina* may be due in part to their removal by Painted Turtles. This seems plausible given that Painted Turtles outnumber Snapping Turtles by 20:1 in Wolf Howl Pond. The higher density of leeches on Snapping Turtles in May may occur because the Painted Turtles do not feed until water temperatures rise above 15°C in late May whereas the leeches are already active and seeking hosts (Brooks et al., 1990). In June and July, when water temperatures rise above 15°C, turtles begin feeding extensively (Sexton 1989; this study). We did not observe Painted Turtles remove leeches from each other, perhaps because leeches were much less abundant on Painted Turtles and even if this feeding did occur it would be brief.

This interaction between Painted and Snapping turtles and leeches may be akin to the mutual association observed between Oxpeckers (*Buphagus erythrorhynchus* and *B. africanus*) in Africa and their mammalian hosts which are usually large ungulates (Benson 1973). The birds feed on the ticks, blood-sucking flies and tissues of their hosts. Through this association, the mammals have pests removed while the birds receive food. As well, in a marine environment, the Neon Cleaner Goby (*Gobiosoma oceanops*) of the Caribbean, and the Cleaner Fish (*Labroides dimidiatus*) of the Indo-Pacific rid larger fish of their ectoparasites (Zander 1974). Similarly, the Painted Turtle receives food

and the Snapping Turtle has leeches and algae removed. In many cases, the "cleaners" are strongly adapted physiologically and ecologically to perform ectoparasite removal and then to derive their food primarily from this source (Snelson et al. 1990). In contrast, the behaviour exhibited by Painted Turtles is likely to be sporadic and facultative, not obligate. Nevertheless, we suggest that this behaviour may affect the numbers of leeches on *Chelydra* and may provide the Painted Turtles with a significant food source.

Although the biological significance of the observed interactions between Painted Turtles and Snapping Turtles at Wolf Howl Pond remains uncertain, it is clear that this behaviour has occurred repeatedly and involved several different turtles over at least two years. Therefore, we suggest these interactions could represent the first reported example of a cleaning symbiosis between turtle species and the first case of a turtle being an active partner in a mutualistic interaction.

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Weissia brachycarpa (Nees & Hornsch.) Jur. at Niagara Falls, A Moss New to Ontario

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Eckel, P. M. 1997. *Weissia brachycarpa* (Nees & Hornsch.) Jur. at Niagara Falls, a moss new to Ontario. *Canadian Field-Naturalist* 111(2): 318–319.

A collection of the rare moss *Weissia brachycarpa* at Niagara Falls, is the first record for Ontario, the third Canadian province in which the species is known to occur. This plant is a noteworthy addition to the unusually rich biodiversity of the Niagara River Gorge.

Key Words: Moss, *Weissia brachycarpa*, Ontario, Niagara Falls.

During a study of the mosses of the Niagara River Gorge the following moss was discovered:

Weissia brachycarpa (Nees & Hornsch.) Jur. Canada: Ontario, Welland, Regional Municipality of Niagara, 43°30'N, 79°10'W, City of Niagara Falls; base of wooded embankment overlooking the Horseshoe (Canadian) Falls; in spray on calcareous clay in lawn; 28 May 1991, Eckel 9302250 (Buffalo Museum of Science).

According to Ireland et al. (1987) *Weissia brachycarpa* in Canada has been found in two provinces: British Columbia at one end of the country and Nova Scotia at the other. Stations reported for the United States by Crum and Anderson (1981) are located south to North Carolina and west to Texas, but otherwise the New World distribution is largely eastern North American. The Old World distribution includes temperate Europe east to the western states of the former Soviet Union. It is considered rare throughout its range (Crum and Anderson 1981).

Weissia brachycarpa has been recorded recently in New York State in nearby Niagara County (Eckel 1987) and just across the Niagara River from the Ontario station on Goat Island in the city of Niagara Falls, New York (Eckel and Eckel 1988). All collections were found at the margins of grassy areas by roadsides or in lawns, a habitat typical for the species. These are the only stations recorded in New York.

As with other species in the genus, now enlarged by the incorporation of *Astomum* (Stoneburner 1985), the plants cannot be identified if sterile. Capsules are necessary for their determination. The capsules of *Weissia brachycarpa* are distinctive in the smallness of the capsule opening, perhaps indicating a tendency of the species toward cleistocarpy, a feature of the subgenus *Astomum*. The capsules and leaves tend to be broader than a more common species, *Weissia controversa* Hedw., with which it could most easily be confused.

Other mosses found associated at the Ontario station were *Amblystegium varium* (Hedw.) Lindb., *Barbula convoluta* Hedw., *B. unguiculata* Hedw.,

Fissidens taxifolius Hedw., *Phascum cuspidatum* Hedw., *Physcomitrium pyriforme* (Hedw.) Hampe, *Pleuridium subulatum* (Hedw.) Rabenh., and *Pottia truncata* (Hedw.) Fuernr. All are typical of disturbed soil. Species found here but not recorded for Welland County (now part of the Regional Municipality of Niagara) according to Ireland and Cain (1975) are *Barbula convoluta*, *B. unguiculata*, *Phascum cuspidatum* and *Pleuridium subulatum*. The last species is known from only seven other stations in Ontario (Ireland and Ley 1992). Specimens of these mosses are deposited at BUF.

The Niagara River Gorge and its environs have supported a rich tradition of bryophyte interest beginning with such notables in the history of bryology as Thomas Drummond, collecting on the Canadian side in the early nineteenth century, continuing with John Macoun, Leo Lesquereux and T. P. James, among others, in the latter part of the nineteenth century. It was also then when Judge George W. Clinton, member of the Regents of the University of the State of New York, made systematic collections of interesting mosses on both sides of the Niagara River for distribution to various herbaria. Nearly all of these individuals included specimens collected at Niagara in exsiccatae distributed in the past century. That the moss flora still has populations of interest is supported by recent discoveries, such as *Eucladium verticillatum* (Brid.) Bruch & Schimp. in BSG in Ontario (Eckel 1990) and *Didymodon australasiae* var. *umbrosus* (C.Muell.) Zand. (Eckel 1986) and *Bryum rubens* Mitt. (Eckel and Shaw 1990) on the American side of the River.

The gorge of the Niagara River is the focus of the distributive power of converging transient human populations. It exists in the midst of several dense transportation networks, not to mention its function as a biological conduit for the Great Lakes watershed, the waters of which are constricted into a strait, bisecting and thereby creating the Niagara Peninsula. Such a concentration of vectors for diaspore movement are coupled with the gorge of the

River: an unusual haven of relatively undisturbed complexes of microhabitats for the capture and retention of such diaspores. These conditions pre-date European migrations into the region, with the consequence that the gorge environment and the microhabitats along its rim contain nearly 75 percent of the biodiversity (of vascular plants) known for western New York and adjacent Ontario (Eckel, manuscript in preparation). The gorge appears to represent a biological sink for the chance seed or spore that happens into it. The extraordinary biodiversity of the Niagara River and gorge environment was noted earlier by David F. Day (1887).

Despite a return to the locality in every year subsequent to the original collection, I have been unable to rediscover the populations of *Weissia brachycarpa*. Whether this is due to their naturally ephemeral nature, to chemical lawn management, or to any of a number of other pressures characteristic of the natural and artificial environment of the area, is unknown.

Acknowledgments

Richard Zander determined the specimen collected at Niagara and the manuscript has benefited from his suggestions and comments. Permission to study the floras of the Niagara Gorge has been granted to the author by the Niagara Parks Commission, Ontario, and the New York State Department of Parks, Recreation and Historic Preservation. This study has been supported in part by a grant from the Niagara Frontier Chapter of the Adirondack Mountain Club.

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The Moss *Tortella alpicola* Dix. New to Alberta and the Yukon Territory with a Discussion of its Range and Comments on Related Species

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Eckel, P. 1997. The moss *Tortella alpicola* Dix. new to Alberta and the Yukon Territory with a discussion of its range and comments on related species. *Canadian Field-Naturalist* 111(2): 320-322.

Tortella alpicola Dix., once considered rare as only a few isolated stations had been recorded in North America, is shown to have a more widespread distribution. Characteristics distinguishing this species from the common and widespread *Tortella fragilis* and *T. tortuosa* are presented in a key.

Key Words: *Tortella alpicola*, *Tortella fragilis*, *Tortella tortuosa*, *Tortella nitida*, Alberta, Canada, Yukon Territory, rare bryophytes, moss.

Among the collections of undetermined bryophyte material of the Geography Department of the University of Calgary (those not sent to the Provincial Museum of Alberta in Edmonton in 1995 and examined subsequent to that year), specimens of *Tortella alpicola* Dix. came to light. The North American distribution of this species, due to taxonomic difficulties, has not yet been adequately documented. The University of Calgary specimens, and three others seen from Canada at other herbaria, represent the present known distribution of the species in that country (herbarium code throughout follows that designated by Holmgren et al. 1990):

Tortella alpicola:

Alberta: Red Deer River Watershed, provincial campsite at junction of James River and Willson Creek on Cochrane-Nordegg Forestry Trunk Road, approx. 51°48'N, 115°03'W, elev. 4400 feet, June 23, 1961, C. D. Bird 6249; with *Encalypta vulgaris* (Geography Department, University of Calgary); Bow River Watershed, 3 miles WSW of Exshaw, SW17-24-9-W5, 51°03'N, 115°13'W, elev. 4300 ft., Upper Foothills Forest, north-facing slope with steep limestone exposures, on May 19, 1976, Glennis Lewis no. 36, with *Encalypta rhaptocarpa* and *Gymnostomum aeruginosum* (BUF); Jasper National Park, *Dryas drummondii* flat 2-3 miles below Athabaska Glacier, July 23, 1959, W. A. Weber B-2278 (COLO).

Northwest Territories: Ellesmere Island, lake east of Taconite Inlet, 82°52'N, 78°05'W, cliff of metamorphic rock, 50 m, May 21, 1969, G. Brassard 4136 (CANM).

Yukon Territory: Selwyn Mountains, Itsi Range, North end of unnamed lake, south of Fuller Lake, 62-57'N, 130-09'W. 1600 m, in mesic *Betula pumila*-*Vaccinium uliginosum* dominated tundra on east and north facing slopes, siliceous rock outcrops of granite and slate present, with small amounts of calcareous rock cropping out, August 10, 1978, D. H. Vitt s.n. (MO).

This species, as *Sarconeurum tortelloides* Greene, was first described from Antarctica (Greene et al. 1970). Robinson (1972) placed the species into the genus *Tortella*. Zander and Hoe (1979) included a

specimen from Hawaii in the distribution under the name *Tortella fragilis* var. *tortelloides* (Greene) Zand. & Hoe, as Zander and Hoe considered it only marginally distinct from *Tortella fragilis* (Hook. & Wils in Drumm.) Limpr. After study of material of the genus *Tortella* from throughout Arctic North America, Zander (manuscript in preparation) concluded that the variety was a good species, as originally determined by Robinson.

Following Zander's decision, Eckel (1991) published the discovery of the species in the conterminous United States from the state of Wyoming, including reference to a station in the Northwest Territories of Canada. The taxon was discussed again by Hyvoenen (1991), who indicated, based on his examination of specimens of *Tortella fragilis* from the southern hemisphere, that *Tortella tortelloides* should be placed under *Tortella fragilis* as a variety again. My examination of specimens at H from Tierra del Fuego collected by H. Roivainen, some of which were annotated by Hyvoenen, has shown all of these specimens to be *Tortella fragilis* var. *fragilis*. None of them were what is indicated here as *Tortella alpicola*. Other specimens at CHR, H, NY and ALTA of both *Tortella fragilis* and *T. tortuosa* collected in the southern hemisphere were all either correctly determined or were species other than *T. alpicola*. So far, the only known southern hemisphere stations for the latter species are in Antarctica. The species has been found in Colombia (Churchill and Linares 1995), and may prove to be a member of the Andean flora. Zander (1993) reported an earlier name for *Tortella tortelloides* based on the type of *T. alpicola* Dixon (1930), collected from a station in the Himalayas.

As a result of my examination of numerous specimens of the genus *Tortella* from North American herbaria, as well as material from the southern hemisphere, *Tortella alpicola*, is reconfirmed taxonomically as a distinct species. Some account of its distribution has begun to emerge, at least in North

America. It is apparently a species of more widespread occurrence than previously thought.

With clarification of its distinctive characters, *Tortella alpicola* is readily differentiated from the two other species in the genus with which it is most often confused: *T. tortuosa* (Hedw.) Limpr. and *T. fragilis*, which are usually robust plants: *T. tortuosa*

can reach 6 cm, *T. fragilis* 5 cm in height, and both are typically two or more cm tall. Since *T. alpicola* is usually only one cm in height (rarely 1.5 cm), the former two species can most often be differentiated by height alone. It is when specimens of any one of the three species are only one cm in height or less that the real confusion arises between them:

Key to North American specimens of *Tortella tortuosa*, *T. fragilis* and *T. alpicola* when stems are only one cm high:

- 1. Leaf apices not deciduous (youngest leaves at the stem apex not propaguloid) with nearly subulate apices composed of more than five cells; leaf cells 8–11 µm wide *Tortella tortuosa*.
- 1. Leaf apices deciduous (youngest leaves at the stem apex with deciduous, propaguloid modifications) the apices mucronate with fewer cells, occasionally to five cells, leaf cells 9–13(–14) µm wide 2.
- 2. Propaguloid apices of youngest leaves in one straight segment without articulations, with smooth, straight margins bordered by elongate, smooth cells; stems usually red-tomentose with fine, conspicuous tomentum *Tortella fragilis*.
- 2. Propaguloid apices of youngest leaves articulated into several “barrel-shaped” segments, with crenulated-papillose margins of quadrate cells; stems without tomentum, or rhizoids sparse and coarse *Tortella alpicola*.

There are other less definite distinctions, such as the snowy white hyaline basal cells in *Tortella alpicola*, while these regions in the other two taxa have a yellowish tint. Both *Tortella tortuosa* and *T. fragilis* have conspicuous red tomentum, but *T. alpicola* does not. The largest specimens of *T. alpicola* seen tend to be more rhizoidiferous than is typical, while small variants of *T. fragilis* tend to have less tomentum, but at least some stems can be found in a collection that are red-tomentose. The clear, smooth elongate cells on the upper margin of especially young leaves of *Tortella fragilis* is a critical character in distinguishing this species from both *T. alpicola* and forms of *T. tortuosa* with which it may be confused (Zander, manuscript in preparation).

Among the specimens seen from the southern hemisphere, a tiny example of *T. fragilis* from Campbell Island in Antarctica proved difficult to differentiate from *T. alpicola*, mainly because of the apparent absence of any propaguliferous leaf apex modifications of any distinction. Although the apices of the leaves were very narrow and deciduous (fragile), most of them possessed the clear border of thicker-walled elongate cells and, with diligence, one or two apices could be found with thickened modifications. The larger average leaf cells of some of these reduced specimens also duplicate the typical size of cells of *T. alpicola*. The specimen was, however, coarse, with blackened tomentum at the very base. The marginal border has proved critical in naming similar specimens of *T. fragilis*.

Actually, the species that is most similar to *T. alpicola*, even to the barrel-shaped segmentation in the apices of the young leaves, is small, narrow-leaved forms of *Trichostomum tenuirostre* (Hook. & Tayl.) Lindb. Specimens of the latter species, however, are readily separated by the thicker-walled cells on the leaf margins at the base, whose cells do not form the characteristic vee-shape of the

genus *Tortella*. There are also occasional low and distant teeth on the upper leaf margin.

Specimens of *Tortella alpicola* seen to date are associated with shaded or exposed, wet or dry rocks, crevices and ledges of granite, quartzite, sandstone and calcareous outcrops on cliffs and in canyons, but also in wet, mesic tundra in the Yukon at elevations between 900 and 3300 m. In addition to its Canadian range, its general distribution so far noted is North America in Alaska, Arizona, Colorado, Idaho, Montana, Nebraska, Utah, Wyoming; South America in Colombia, Asia in India, Pacific Islands in Hawaii, and Antarctica (Alexandra Island).

That a peculiar species of *Tortella* occurs in our flora has shown itself in the literature in various ways. *Tortella nitida* (Lindb.) Broth. was ascribed to the North American flora by Haring (1938) and Flowers (1973). This has been suggested to be a variety of *Tortella tortuosa* by Crum and Anderson (1981), who also state that material cited as *T. nitida* by Haring was in fact either *T. fragilis* or *T. tortuosa*. Material from Utah, described by Flowers, does not appear to have been seen by them.

Tortella nitida, a European species, however, has basal cells gradually, not abruptly, differentiated from the laminal cells, a shining costa on the dorsal leaf surface with no distinctive subulate propaguloid leaf apex, and leaf cells to 10 µm wide. *Tortella nitida*, by reason of its basal cells and other characters, has been thought to possibly be a fragile-leaved form of *Trichostomum crispulum* (R. Zander, personal communication). North American material examined for the present study that was named *Tortella nitida* is variously *T. alpicola*, *T. fragilis*, *T. tortuosa* and *Trichostomum tenuirostre*, with *Tortella alpicola* specimens predominating in the western United States of Utah and Colorado. *Tortella alpicola* differs from *T. nitida* immediately

in the brightly distinct, clear basal cells set off from the green laminal cells as well as the other characters mentioned. One specimen cited as *T. nitida* from Alaska proved to be *Trichostomum tenuirostre*, distinguished by the basal cells not in a vee-shape, bulging-mammillose cells, and tiny papillae often arranged in two parallel rows over each lumen.

Specimens of *T. alpicola* from North America have also been called *T. rigens* N. Alberts. (Weber 1973) due to the wide leaf cells (ca. 14 µm), but plants of that species in Sweden are longer, 1.5–3 cm high, and lack apical propagulae (*see also* Nyholm 1989). Examination of material of this species from Sweden showed *T. rigens* to have a strong morphological similarity to *T. fragilis* and to be different in many characters from *T. alpicola*, especially in leaf shape and color.

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I thank the curators of bryophytes at ALTA, CANM, CHR, COLO, H, MO, and NY for allowing the examination of specimens from their herbaria. I am grateful to Richard Zander, who permitted me access to his unpublished manuscript discussing the genus *Tortella* in Arctic North America, and who reviewed the present paper. Outside reviewers contributed substantially to improvements in the manuscript.

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News and Comment

Editor's Report for *The Canadian Field-Naturalist* Volume 110 (1996)

Research, observation, synthesis, or tribute manuscripts submitted to *The Canadian Field-Naturalist* totalled 125 in 1996, an increase of 30 over 1995. Reviews were completed for all but 21 by the end of the year. Of the 104 returned to authors, 72 were revised and accepted within the year. In addition, 37 revisions of manuscripts submitted in 1995 and 1 submitted in 1993 were received and accepted. Of the 110 accepted, 55 were published in 1996 and 55 are in galley, or submitted to the printer to be set, for 1997. These will fill issues 111(1), (2), and (3).

Totals for circulation to members and subscribers to *The Canadian Field-Naturalist* in 1996 together with those of 1995 are given in Table 1. Total copies distributed were only down by 22 despite a drop in memberships of 30.

Issue mailing dates for volume 110 were: (1) 30 April, (2) 4 July, (3) 22 November 1996, and (4) 2 April 1997. The volume totalled 762 pages; the largest single issue (1) was 254 pages. This, the largest in the journal's history, was a special issue: "A Life with Birds: Percy A. Taverner, Canadian Ornithologist, 1875" a biography by John L. Cranmer-Byng (see Editor's Report for Volume 109 *The Canadian Field-Naturalist* 110(2): 360-363 for acknowledgements to the numerous people who assisted with this issue).

Special thanks are due to Joan Hebden who prepared the tribute to the late honorary member, Claude Eugene Garton (1907-1996). This appeared in 110(3): 554-557, and the many people in the Thunder Bay area who assisted her, the editor, or both, with this article are acknowledged in the tribute individually.

The number of articles and notes in volume 110 is summarized in Table 2 by topic. The totals for Book Reviews and New Titles are given in Table 3, and the distribution of published pages among issues in Table 4.

Prepared this year for Volume 111, number 1, was another Special Issue: "Orchids in the Ottawa District: Floristics, Phytogeography, Populations Studies and Historical Review" by Joyce Reddoch and Allan Reddoch. This study synthesized over 30 years of detailed study, as well as historical observations back to the 1850s, in the area 50-km radius from the Parliament Buildings by the authors and members of the Ottawa Field-Naturalists' Club, and provides original data for this area for 44 species included. Prepared for 111(2) were six COSEWIC status reports for Fish and Marine Mammals approved in 1995.

M.O.M. Printers, 300 Parkdale Avenue, Ottawa, set and printed the journal and special thanks are due Emile Holst and Eddie Finnigan and their staff. Wanda J. Cook proof-read the galleys for the volume. Bill Cody continued as Business Manager, a role he has shouldered well since he was appointed "Treasurer's Assistant" 21 May 1947 (soon after initially joining the Club 7 December 1946). The title of the expanding post was changed to "Business Manager" 15 December 1948. [Special thanks to the informal club historian, Dan Brunton, for this information from his notes on the Minutes of OFNC Council]. Bill was assisted by Lois Cody who formally relinquished her long-time role of assistant to the Business Manager during the year. Bill also oversaw the compilation, and proof-read and edited, the Index for volume 110 which was diligently pre-

TABLE 1. The 1996 circulation of *The Canadian Field-Naturalist* (with 1995 figures in parenthesis). Membership totals from Membership Committee analysis, Annual Report of the Ottawa Field-Naturalists' Club (page 334); subscription totals compiled by W. J. Cody. Forty percent of membership dues and 100% of subscription payments go to production of *The Canadian Field-Naturalist*. Members can vote on Club affairs, subscribers can not.

	Canada		USA		Foreign		Totals	
Memberships								
Family & individual	987	(1017)	32	(31)	5	(6)	1024	(1054)
Subscriptions								
Individual	186	(170)	62	(61)	6	(8)	254	(239)
Libraries	198	(206)	267	(266)	46	(46)	511	(518)
TOTALS	1371	(1393)	361	(358)	57	(60)	1789	(1811)

TABLE 2. Number of articles and notes published in *The Canadian Field-Naturalist* Volume 110 (1996) by major field of study.

Subject	Articles	Notes	Total
Mammals	17	14	31
Birds	11	9	20
Amphibians and reptiles	2	1	3
Fish	7	2	9
Invertebrates	2	0	2
Plants	8	2	10
Other*	1*	0	1*
Totals	48	28	76

*COSEWIC Fish and Marine Mammal Subcommittee report 110(3). In addition, there was one tribute article (Claude Eugene Garton) in News and Comment section 110(3).

pared by Leslie Durocher. Wilson Eedy continued as Book-Review Editor, including compilation of New Titles, despite his ever-increasing world travel on other duties (his detailed annual report will appear separately). George La Roi continued to serve as Coordinator of the Biological Flora of Canada (a summary of this series will appear separately).

All article and note manuscripts submitted to the *Canadian Field-Naturalist* are normally reviewed by at least one associate editor and usually by one or more additional reviewers as well. This combination of associate editors who review the majority of manuscripts submitted in a field through the year plus outside specialists (chosen by the editor or an associate editor, or selected from alternates suggested by authors) who may see only one (but sometimes more) CFN manuscript(s) a year maintains a balance of both consistency and freshness of opinion. The editor makes the final decisions on manuscripts and corresponds with the authors, largely based on the advice of all reviewers. I am indebted to all who returned reviews in 1996 (if more than one review, the number is in parenthesis):

Associate Editors (listed also on inside front cover of each issue): Mammalogy: William O. Pruitt, Jr.,

Department of Zoology, University of Manitoba, Winnipeg (34; plus 3 reviewed by others); Warren B. Ballard, Wildlife Research Unit, Faculty of Forestry, University of New Brunswick, Fredericton, and [28 August] Arizona Game and Fish Department, Phoenix (17; and additional comments on 16 reviewed by others); Ornithology: Anthony J. Erskine, Sackville, New Brunswick (33); W. Earl Godfrey, Canadian Museum of Nature, Ottawa, Ontario (9); Fish and Marine Mammals: Robert R. Campbell, Woodlawn, Ontario (3; plus 15 COSEWIC status reports); Ichthyology: Brian W. Coad, Canadian Museum of Nature (2); Entomology: R. Anderson, Canadian Museum of Nature (5); Botany: Charles D. Bird, Erskine, Alberta (17). Joining the Associate Editors in 1997 will be Paul Catling, Agriculture Canada, Ottawa. In addition Claude Renaud, Canadian Museum of Nature, gave special assistance with editing the french abstracts of the COSEWIC fish and marine mammal status reports.

Additional reviewers: Brad Andres, U.S. Fish and Wildlife Service, Anchorage, Alaska; Todd Arnold, Department of Wildlife Humbolt State University, Arcata, California; Darlene Balkwill, Canadian Museum of Nature; J. F. Barr, Guelph, Ontario; Spencer C. H. Barrett, Department of Botany, University of Toronto; Rene J. Belland, Devonian Botanical Garden, University of Alberta, Edmonton; J. Roger Bider, Department of Renewable Resources MacDonald College of McGill University and the Ecomuseum, Ste. Anne de Bellevue, Quebec (3); D. A. Boag, Brentwood Bay, British Columbia (3); Stan Boutin, Department of Biological Sciences, University of Alberta, Edmonton, Alberta; Jeff Bowman, New Brunswick Cooperative Fish and Wildlife Research Unit, University of New Brunswick, Fredericton (3); Ronald J. Brooks, Department of Zoology, University of Guelph; Luc Brouillet, Herberier Marie-Victorin, Institute botanique, Université de Montreal; Daniel F. Brunton, Ottawa (2); Ludwig Carbyn, Canadian Wildlife Service, Edmonton (2); Paul M. Catling, Agriculture Canada, Ottawa (6); Nigel Caulkett, Department of Veterinary Anesthesiology, Radiology, and Surgery, Western College of Veterinary Medicine, Saskatoon, Saskatchewan; Jacques Cayouette, Agriculture Canada, Ottawa; Robert G. Clark, Canadian Wildlife Service, Saskatoon, Saskatchewan; W. J. Cody, Agriculture Canada, Ottawa (2); William J. Crins, Ontario Ministry of Natural Resources, Huntsville; Vince Crichton, Manitoba Department of Natural Resources, Winnipeg (3); Peter Ross Croskery, Grimsby, Ontario; Stephen Darbyshire, Agriculture Canada; A. W. Diamond, Department of Biology, University of New Brunswick, Fredericton; George W. Douglas, British Columbia Conservation Data

TABLE 3. Number of reviews and new titles published in Book Review section of *The Canadian Field-Naturalist* Volume 110, by topic.

	Reviews	New Titles
Zoology	18	87
Botany	13	51
Environment	15	74
Miscellaneous	3	12
Young Naturalists	0	44
Totals	49	268

TABLE 4. Number of pages published in *The Canadian Field-Naturalist* Volume 110 (1996) by section (number of manuscripts in parenthesis).

Issue number	- 1 -	- 2 -	- 3 -	- 4 -	Total
Articles	243 (1)	76 (13)	146 (17)	127 (17)	592 (48)
Notes	- -	23 (12)	12 (6)	18 (10)	52 (28)
News and Comment	2 (2)	17 (20)	11 (23)	1 (2)	34 (44)
Book Reviews	- -	16 (17)	14 (18)	14 (13)	43 (49)
Index	9 (1)	- -	- -	29 (14)	38 (2)
Notices	- -	- -	- -	2 (2)	2 (2)
Advice to Contributors	- -	- -	- -	1 (1)	1 (1)
Total pages:	254	132	184	192	762

*Total pages for book review section include both reviews and new titles listings but parenthesis figures include only the number of reviews.

Centre, Victoria; David Duncan, Saskatchewan Wetland Conservation Corporation, Regina; Graham Forbes, Wildlife Research Unit, Faculty of Forestry, University of New Brunswick, Fredericton; Bill Freedman, Department of Biology, Dalhousie University, Halifax, Nova Scotia (2); Chuck Geale, Tree Canada Foundation, Ottawa; Lynn Gillespie, Canadian Museum of Nature; Mark Fuller, Raptor Research and Technical Assistance Centre, National Biological Service, Boise, Idaho; Frank S. Gilliam, Department of Biological Sciences, Marshall University, Huntington, West Virginia; Karan Graham, Department of Zoology, University of Guelph, Ontario; Patrick T. Gregory, Department of Biology, University of Victoria, British Columbia (2); Graham Griffiths, Department of Biological Sciences, University of Alberta, Edmonton; Thomas Herman, Biology Department, Acadia University, Wolfville, Nova Scotia; Stuart Houston, Saskatoon, Saskatchewan; Richard L. Hutto, Division of Biological Sciences, University of Montana, Missoula; Robert Ireland, Nepean, Ontario (5); Ross D. James, Sunderland, Ontario (3); Stephen Jenkins, Department of Biology, University of Nevada, Reno (3); William Jensen, North Dakota Game and Fish Department, Bismarck; Tony Keith, Canadian Wildlife Service, Hull, Quebec; Brina Kessel, University of Alaska Museum, Fairbanks, Alaska; Edward Kott, Department of Biology, Sir Wilfred Laurier University, Waterloo; Paul A. Krausman, College of Agriculture, School of Renewable Natural Resources, University of Arizona, Tucson, Arizona; Karl W. Larsen, Alberta Pacific Forest Industries Inc., Boyle; Yves de Lafontaine, Saint-Laurent Vision 2000, Environment Canada, Montreal, Quebec; Raymond LeClair, Department de Cimie-Biologie, Université du Quebec à Trois Rivières; Ross Lein, Department of Biology, University of Calgary; Diane L. Leudorf, Department of Biology, York University, North York, Ontario; Nora Lewis, Department of Animal

Science (Agriculture), University of Manitoba, Winnipeg; Lawrence E. Licht, Department of Biology, York University, North York, Ontario; W. Bruce McGillivray, Provincial Museum of Alberta, Edmonton; Mike Malhiot, Ontario Ministry of Natural Resources, Wingham; John Maunder, Newfoundland Museum, St. John's; Norton Miller, Biological Survey, New York State Museum, Albany; L. David Mech, U.S. Fish & Wildlife Service, N. Central Forest Experiment Station, St. Paul, Minnesota; David Nagorsen, Vertebrate Unit, Royal British Columbia Museum, Victoria (5); R. W. Nero, Manitoba Natural Resources, Winnipeg; Thomas W. Nudds, Department of Biology, University of Guelph, Ontario; Martyn E. Obbard, Ontario Ministry of Natural Resources, Maple; Henri Ouellet, Canadian Museum of Nature; Gerry Parker, Canadian Wildlife Service, Sackville, New Brunswick (2); Lawrence Powell, Department of Biology, University of Calgary, Alberta (2); William F. Porter State University of New York, College of Environmental Science and Forestry, Syracuse; William B. Preston, Manitoba Museum of Man and Nature, Winnipeg (2); Gilbert Proulx, Alpha Wildlife and Management Limited, Sherwood Park, Alberta (6); Scott Redhead, Agriculture Canada, Ottawa (2); William D. Reese, Department of Biology, University of Southwestern Louisiana, Lafayette; Randall Reeves, Okapi Wildlife Associates, Hudson, Quebec (2); T. E. Reimchen, University of Victoria, British Columbia; Claude Renaud, Canadian Museum of Nature; A. A. Reznicek, University of Michigan Herbarium, Ann Arbor; Fred Scott, Wildlife Museum, Acadia University, Wolfville, Nova Scotia; Spencer G. Sealy, Department of Zoology, University of Manitoba, Winnipeg; Dianne Secoy, Biology Department, University of Saskatchewan, Regina; Bradley Sinclair, Department of Environmental Biology, Ontario Agricultural College, University of Guelph; J. M. Soper, Ottawa; K. W. Stewart, Zoology Department,

University of Manitoba, Winnipeg (2); Tom Sullivan, Faculty of Forestry, University of British Columbia, Vancouver; Edmund S. Telfer, Canadian Wildlife Service, Edmonton; Gary J. Umphrey, Department of Zoology, University of Western Ontario, London; Leslie A. Viereck, Institute of Northern Forestry, Fairbanks, Alaska (2); Marc-Andre Villard, Department of Biology, University of Moncton, New Brunswick; Dennis Voigt, Ontario Ministry of Natural Resources, Maple; Robin Walsh, Fairview, Alberta; Patrick J. Weatherhead, Department of Biology, Carleton University, Ottawa; Michelle Wheatley, Kanata, Ontario (2); Heather Whitlaw, Wildlife Research Unit, Faculty of Forestry, University of New Brunswick, Fredericton and Phoenix, Arizona (5)

[with apologies for a typo in her name in the last Editor's Report in the apology for one in a previous report]; P. M. Youngman, Ottawa.

I am also indebted to David Moore, President of the Ottawa Field-Naturalists' Club, the Club Council, Chairman Ron Bedford and the Publications Committee of the OFNC for their support, to the administration and staff of The Canadian Museum of Nature for allowing me to continued use of its library and the facilities at the Macoun Nature Centre at Aylmer, and to Joyce for continuing encouragement at home throughout another year.

FRANCIS R. COOK
Editor

Global Biodiversity: The Canadian Museum of Nature

Volume 6, Numbers 3 and 4, winter 1996 and spring 1997, respectively, are both 48 pages, edited by Don E. McAllister and published by Canadian Museum of Nature. For subscription or more information contact Global Biodiversity Business Manager Dawn Arnold, or Subscription Manager Susan Swan, Canadian Museum of Nature, P. O. Box 3433, Station D, Ottawa, Ontario, Canada K0G 1R0; Phone (613) 993-5908; Fax (613) 990-0318; e-mail darnold@mus-nature.ca.

Volume 6, Number 3, Winter 1996: The impact of seaweed introductions on biodiversity by Robert E. De Wreede – Schoolyard greening: The biodiversity connection by Ann Coffey – Can we predict the fluctuations of ecosystem species richness? by Marc Proulx – Do medicinal plants have a place in today's medicine? by N. N. Malo and R. Roy – Eco-Products: Ecofoam, duplex printers, and energy efficient computers – Views: Evolution will not evolve us by Anurag A. Agrawal – A Portrait of Biodiversity: *Bombus occidentalis* robbing *Ipomopsis aggregata* – Biodiversity Reports: International Coral Reef Symposium; The Second World Congress on the Preservation and Conservation of Natural History Collections; Global Biodiversity Forum; IUCN-WCC; Convention of Biological Diversity: COP-3; Biodiversity News – Cyberdiversity – Biodiversity meetings – Book and periodical niche – The Last Word: West Africa gets going by Jean Lauriault.

Volume 6, Number 4, Spring 1997: Biodiversity, ecodiversity, sociodiversity: three aspects of diversity, Part 1 by Pierre Dansereau [with emphasis on the first of the terms, subsequent issues will cover the other two] – Lighting a sacred fire by Naigzy

Gebremedbin [from Eritrea, based on a speech to the Ministerial section of the Conference of the Parties of the Biodiversity Convention (COP-2) in Jakarta in 1995] – Biodiversity and the Bible by Calvin B. DeWitt – Impressions of the Amazon at age 12 by Don Chao – A Portrait of Biodiversity: Large marble butterfly, *Euchloe ausonides* ssp. – Limitations of endangered species lists by Lee Harding – Initiatives and Successes: International Summer School on Biodiversity & Systematics; A Charter for Earth: A code of conduct for humans in regard to nature; A new industry: conch farming] – Biodiversity News: British Columbian and Nova Scotia get top marks in protecting wilderness; Celebrating the Portuguese centennial of oceanography; Global hazardous chemicals agreement on its way; Population, environment, and Canadian Policy; Canadian environmental philanthropy – donating your lands for conservation purposes; Canadian study on Biodiversity Law and Policy now available; New Fish Protection Act for British Columbia; Storm-water pollution survey has good news and bad news; LEAD Canada now accepting applications; Discontinuation of the ATBI [= All Taxa Biodiversity Inventory; Costa Rica]; Petawawa National Forestry Institute closes; Environment Canada and State of Sao Paulo undertake watershed project; New citizen's handbook on wetlands available now; We've moved! – Cyberdiversity: Biodiversity and the Internet – Biodiversity Meetings – Book and Periodical Niche – Index Volume 6 – The Last Word: Pierre Dansereau, the barefoot ecologist by Jacques Prescott.

FRANCIS R. COOK

Rana-Sauria

The newsletter of the Quebec Amphibian monitoring program and the Atlas of the Amphibians of Quebec, Volume 3, Number 2, December 1996. This is the first issue prepared by David Rodrigue, who has replaced Sylvie Mattee, the first editor of the newsletter and co-author with Roger Bider of the first three Quebec Atlas editions. This issue begins with "A Word from the new coordinator", and is followed by "The amphibian population follow-up: four years later; 1996 objectives; Top species for 1996"; "The coordinator's year end comments: The survey roads,

The reproductive sites"; "Urban sprawl"; "It only happens to others ..."; "Participants in the 1996 amphibian population monitoring program" and "The Atlas of Amphibians and Reptiles of Quebec". More information on the atlas, the monitoring programs, and the newsletter are available from David Rodrigue, St. Lawrence Valley Natural History Society, 21125 ch. Ste-Marie, Ste-Anne-de-Bellevue, Quebec H9X 3L2. Telephone: (514) 457-9449; Fax: (514) 457-0769; e-mail ecomus@total.net.

FRANCIS R. COOK

CITES Reports: 1992 Annual Report for Canada

This CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) report (Number 20) issued for Canada by the Canadian Wildlife Service, Environment Canada, received at *The Canadian Field-Naturalist* 15 January 1997, is dated "November 1996" and covers imports and exports of whole animals, plants and their parts or derivatives for Canada in 1992. It was prepared by Jean R. Robillard and Francois Pilon. After a 4-page of introduction, 84 pages list transactions in species designated on Appendix I and II in six tables: Living specimens (1) exported or re-exported; (2) imported; Dead specimens, parts and

derivatives (3) exported or re-exported; (4) imported; and transactions made under (5) temporary import/export certificates and (6) scientific import/export certificates. In 1992, the federal government issued 114 Import Permits (102 in 1991), 3986 (2714) Export Permits, 95 (111) Temporary Export/Import Certificates, and 38 (34) Scientific Certificates. Provincial/Territorial governments issued 10393 (3174). Much of the latter increase is attributed to the placing of the Black Bear on Appendix II, 11 June 1992.

FRANCIS R. COOK

***Froglog*: Newsletter of the Declining Amphibians Populations Task Force of the World Conservation Union's Species Survival Commission**

Number 20, January 1997: More seed grants available – The DAPTF in Prague – Amphibian re-introduction symposium report [15 August 1996 at the Royal Botanical Gardens, Hamilton] – The status of amphibians in Slovenia – *Nyctibrachus major* in Malnad, India – Stability for Swedish treefrogs? – Toads in the United Arab Emirates – The effect of aquatic acidification on *Rana pipiens* – USA national coordinator's Report – *Froglog* shorts – Publications of interest.

Number, 21, March 1997: Anonymous donation boosts seed grant funds – Hungarian Working Group report and the *Year of the Salamander* – Conservation meeting in Hungary – Amphibians in

Portugal – Herbicides kill frogs – 1996 IUCN Red List – Georgia Herp Atlas – U.S. amphibian teaching packs – Taiwan amphibian status – Report from the Urals – Toad Mortality – *Froglog* shorts – Publications of interest.

Froglog is available by writing John W. Wilkinson, Department of Biology, The Open University, Walton Hall, Milton Keynes, MK7 6AA, United Kingdom; e-mail DAPTF@open.ac.uk; or on the World Wide Web at the following URL:

<http://acs-info.open.ac.uk/info/newsletters/FROGLOG.html>

FRANCIS R. COOK

Ontario Natural Heritage Information Centre Newsletter

Volume 3, Number 1, Winter 1996/1997 contains 12 pages of news items including a report on the Ontario Ministry of Natural Resources Ecologists Meeting 9-10 October 1996. Also featured is a Community Ecology section: Rare Communities, an article on Glaciere Talus at the spectacular gorges at Ouimet Canyon and Cavern Lake Canyon northeast of Thunder Bay. There is an announcement that a Vegetation Community Ranks List is now available; progress in the Mapping of Rare Vegetation Communities from Original Land Survey Notes Project; and an update on the Vegetation Community Catalogue. An atlas of Ontario Dragonflies and Damselflies database is reported as reaching 4000 records from the published literature, with compilation of records from naturalists and museum collections proceeding. An Ontario perspective of

RENEW (Recovery of Nationally Endangered Wildlife) is given, as are 1996 Botanical highlights, notice of the NHIC Amphibian and Reptile and Rare Vascular Plant lists, and progress on the Trent University Herbaria record computerization. There is an account of the Site District Boundary Refinement and Revision in Site Regions 6 and 7. News and notes cover the IUCN World Conservation Congress in Montreal in October 1996; International Visitors at the NHIC; the 1996 A. D. Latornell Conservation Symposium; and a New MNR Vulnerable, Threatened and Endangered Species List. As well, there is a focus item on the indefatigable Mike Oldham, the botanist/herpetologist of the National Heritage Information Section since its inception.

FRANCIS R. COOK

Renew Report #6: 1995-96

This bulletin, 32 pages, has been issued by the (Canadian) Committee on the Recovery of Nationally Endangered Wildlife. The latter involves non-governmental organizations and federal, provincial and territorial agencies in coordinating and promoting wildlife conservation. It is chaired by David Brackett, Director General of the Canadian Wildlife Service. This report has an Executive Summary review of the year 1 April 1995 to 31 March 1996 of successes and failures for species at risk, followed with individual mention (updates of progress to date, or admissions of insufficient time to organize a committee yet) for 42 species of those designated Endangered, Threatened or Vulnerable by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). There is a separate "1995 list of Species at Risk Designated by COSEWIC". Also included are a section on funding sources for RENEW, profiles of featured Team

Leaders Diane Amirault and Doug Janz, a listing of all Recovery Team members, a summary of the Status of Recovery Plans, Province and Territory addresses for more information and the 16 organizations that are RENEW members.

The work being done is impressive and the support credible but, arguably, a sour note is the occasional glib plan and action outlined for "re-introduction" of some apparently extirpated Canadian populations. Once lost, a population may not be accurately restored with stock obtained elsewhere, and, although this may not be noticeable to the public, what is the point? Such attempts may fail more often than they succeed, and regardless of "success" are a squandering of precious funds that are sorely needed to preserve habitats of populations of species which have actually survived so far in Canada.

FRANCIS R. COOK

Sea Wind

Volume 10, Number 4, October-December 1996, contains features on Sea Reform – Counterpart to Land; News from OVI [Ocean Voice International]; A charter for Earth: A code of conduct for humans in regard to nature; Seahorse Conservation in the Central Philippines: A community-based approach; The economic benefits of tourism in the marine reserve of Apo Island, Philippines; The impacts of fishing gear on seafloor habitats; Coral reef conservation in Indiana. A section titled Sea News includes the startling item that the IUCN has deter-

mined, based on analysis of 35 years of data from 500 scientists worldwide, that (world-wide) 5205 vertebrates are endangered: including nearly 25% of mammals, 25% of amphibians, 20% of reptiles, 34% of fish. Concluding sections, The Booke Nooke contains six book and journal reviews; On the Net details on seven web sites or e-mail addresses; and Conferences lists four upcoming notable meetings, with two more included on the inside back cover.

FRANCIS R. COOK

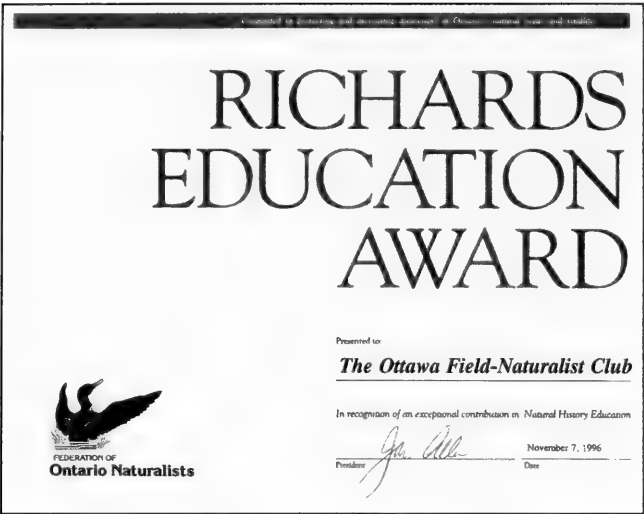
Richards Natural History Education Award by Federation of Ontario Naturalists

The Richards Memorial Award for excellence in Natural History Education was presented to the Ottawa Field-Naturalists' Club at the 65th Anniversary Dinner of the Federation of Ontario Naturalists in Toronto, 7 November 1996. Accepting the big silver trophy on behalf of the OFNC was Bill Cody. The Federation of Ontario Naturalists was founded in 1931 to represent naturalists on provincial issues. At that time it consisted of seven nature clubs and 28 individual members. Today it represents 83 clubs (including The Ottawa Field-Naturalists' Club) and associated groups and 15 000 individual naturalists. The Richards Award is made in recognition of a special contribution to natural history education. Mr. Norman W. J. Richards, after whom the award is named, was a forester who took a keen interest in improving natural history education.

The Richards Natural History Education Award was presented to the OFNC in recognition of the contribution made by our scientific journal, *The Canadian Field-Naturalist*; the first time in the history of the award that a team rather than an individual has been recognized by it. Much of the success of this journal over the last half of this century is due to Bill Cody, the Business Manager for nearly 50 years, first appointed "Treasurer's Assistant" 21 April 1947; retitled the following year) and to Francis Cook, present and longest serving editor (over 20 years: 1962-1966; 1981-present) who has continued many traditions initiated by predecessors, most recently (since 1942) Harold Senn, Bob Hamilton, Ted Mosquin and Lorraine Smith. These efforts combine with those of the Associate Editors, outside reviewers, Editor's and Business Manager's assistants, copy editor, index compilers, the sup-



The cup symbolizing the Norman W. J. Richards Memorial Award with (left and right standing) Dave Moore, President, and Ron Bedford, Chair, Publications Committee, The Ottawa Field-Naturalists' Club; and (seated) William J. Cody, Business Manager, and Francis R. Cook, Editor, *The Canadian Field-Naturalist*.



The Richards Education Award certificate
7 November 1996.

port of The Ottawa Field-Naturalists’s Club Publication Committee, Council Club, membership, and the authors who have submitted to the journal. We are pleased to see these efforts officially recognized for their provincial, national and international significance.

Two recent special issues are especially noteworthy. They are: Volume 109, Number 3; The History of the Exploration of the Vascular Flora of Canada, Saint-Pierre et Miquelon and Greenland and; Volume 110 Number 1; A Life with Birds: Percy A. Taverner. Funding special issues requires a departure from normal practise since much of the revenue from page, table, figure and reprint charges assessed authors and their institutions is unavailable. Normally, such charges cover 40 to 50% of the cost (contributions from membership dues usually amount to just over 10%). Upon a recommendation by the Publications Committee, the Council approved the withdrawal of funds from Club financial reserves to compensate for this loss of revenue. The Vascular Flora issue was co-sponsored by the Missouri Botanical Garden and

Recipients of the Norman W. J. Richards Memorial Award for excellence in Natural History Education presented annually by the Federation of Ontario Naturalists

1979	William Stirling
1980	Audrey Wilson
1981	Kenneth Strasser
1982	Anne Robertson
1983	Ron Strickland, Ron Tozer
1984	Audrey Wilson
1985	Clarke Birchard
1986	Douglas Sadler
1987	Alan Watson
1988	Robert Dorney
1989	Horace Milson
1990	—
1991	Bill Wilson
1992	Sandy Symmes
1993	Jim Rule
1994	Anne Range
1995	Kittie Fells
1996	The Ottawa Field-Naturalists’ Club

the Taverner issue costs were partly recovered through additional sales of specially hard-bound copies.

The Federation of Ontario Naturalists instigated the Richards Education award in 1979. This is the 17th time that it has been presented. Some previous winners that may be recognized by Club members are Doug Sadler of Peterborough for his books on nature interpretation, Dan Strickland and Ron Tozer for the interpretation programs in Algonquin Park, Anne Robertson of Kingston for her work with junior naturalists and Sandy Symmes for natural history interpretation with the Credit Valley Conservation Authority. We work regularly with Sandy who is the co-ordinator of regional councils for the Federation of Ontario Naturalists.

FRANK POPE
Past President, The Ottawa Field-Naturalists’ Club

Minutes of the 118th Annual Business Meeting of The Ottawa Field-Naturalists' Club, 14 January 1997

Place and Time: Canadian Museum of Nature,
Metcalfe and McLeod Streets, Ottawa, 7:30 p.m.
Chairperson: Dave Moore, President
Attendance: Forty-two persons attended the meeting.

Dave Moore opened the meeting by asking members to spend the first half hour reviewing copies of the minutes of the previous meeting, the Treasurer's Report, and the reports of the Committees.

1. Minutes of the Previous Meeting

No errors or omissions were identified. It was moved by Frank Pope (2nd Tom Reeve) that the minutes be accepted.
(Motion Carried)

2. Business Arising from the Minutes

There was no business arising from the minutes.

3. Treasurer's Report

Gillian Marston opened her remarks by noting the favourable report from the Club's Auditor. In reviewing details of the financial statements, she noted, among other things, a decrease in Member's Equity from \$233,483 to \$212,315 and an increase in the de Kiriline-Lawrence Fund from \$12,749 to \$15,432. In response to a question from the floor, Gillian explained that the Fund had been established in honour of Louise de Kiriline Lawrence to support the conservation of natural areas, and gave several examples of how this could be done. She noted an increase in the cost of publishing *The Canadian Field-Naturalist*, in what appears to be a trend. In response to a question from the floor, it was agreed that the last line of the Statement of Operations-CFN, should read "Expenses over Income".

It was moved by Gillian Marston (2nd Ken Young) that the Treasurer's report be accepted.
(Motion Carried)

4. Committee Reports

Dave Moore introduced each of the Committee reports and asked for comments and questions. There were none. He noted that the Executive Committee did not meet in 1996.

It was moved by Tom Reeve (2nd Colin Gaskell) that the Committee reports be accepted.
(Motion Carried)

5. Nomination of the Auditor

It was moved by Ken Young (2nd Frank Pope) that Janet Gehr continue as Auditor for another year.
(Motion Carried)

6. Report of the Nominating Committee

As Chairperson of the Nominating Committee, Frank Pope presented the report of the Committee. He explained that calls for nominations had been placed in both *The Canadian Field-Naturalist* and *Trail & Landscape* and that a special insert had been included with membership renewal forms requesting nominations for a Treasurer. No nominations were forthcoming from these initiatives. The Committee was unable to identify a candidate for the position of Treasurer but will continue its effort to find one. The Committee presented the following list of candidates for the 1997 Council (new members are indicated with an asterisk):

President	Dave Moore
Vice-President	Michael Murphy
Vice-President	(vacant)
Recording Secretary	Dave Smythe
Corresponding Secretary	Lee Cairnie
Treasurer	(vacant)
Other Council Members	Ron Bedford
	Stephen Bridgett*
	Fenja Brodo
	Bill Cody
	Francis Cook
	Ellaine Dickson
	Barbara Gaertner*
	Alan German
	Jeff Harrison
	Philip Martin*
	Patricia Narraway
	Isabel Nicol*
	Frank Pope
	Tom Reeve
	Stan Rosenbaum*
	Chris Traynor
	Ken Young
	Eleanor Zurbrigg*

Seven members of the 1996 Council chose not to stand for re-election: Eileen Evans, Colin Gaskill, Christine Hanrahan, Cendrine Huemer, Anne MacKenzie, Gillian Marston, and Jane Topping. Frank thanked them for their service on Council and said that he was certain they would continue to contribute in other ways.

It was moved by Frank Pope (2nd Mike Murphy) that the proposed slate be accepted.

(Motion Carried)

7. New Business

Dave Moore informed the meeting that the Club had received recognition for its work in the form of two awards in 1996. In June, Jeff Harrison received the City of Ottawa Environmental Award, Community Group, on behalf of the Fletcher Wildlife Garden and the Club. A framed Certificate recording this event is now installed in the Interpretive Centre. In October, the Club learned that the Federation of Ontario Naturalists had awarded it the 1996 Richards Natural History Education Award for the Club's work in publishing the Canadian Field-Naturalist. Bill Cody attended the Award Ceremony in Toronto and returned with a handsome trophy which was displayed at the meeting and will be in the Club's possession for the next year.

8. Presentation

Mike Murphy gave a presentation on the history of the Birds Committee. The Club has always had some part of itself associated with the study of birds; an Ornithology Branch in the early years, and a Bird Census Committee established in the late 1910s, which subsequently evolved into the Bird Records Committee and the Bird Feeder Committee in 1971. In 1980, the Council approved the formation of the present Birds Committee as one of twelve Standing Committees of the Club. Its mandate includes the maintenance of bird records, feeders, the "birding Hotline", and other birding activities. New activities include helping the Fletcher Wildlife Garden to organize the Taverner Cup competition. Mike concluded his presentation by inviting members to contact the Committee's Chairperson, Chris Traynor, for further information.

9. Adjournment

At 8:50 p.m., it was moved by Tom Reeve (2nd Ellaine Dickson) that the meeting be adjourned.

(Motion Carried)

DAVE SMYTHE
Recording Secretary

Committee Reports for 1996 to The Ottawa Field-Naturalists' Club

Awards Committee

The following awards were presented at the Annual Soiree held on April 26, 1996:

1995 – MEMBER OF THE YEAR AWARD: Bob Bracken for the sharing of his knowledge of the flora and fauna of the National Capital Region on numerous field trips.

1995 – ANNE HANES NATURAL HISTORY AWARD: Marilyn Light for her eleven-year study of the population dynamics of orchids in Gatineau Park.

1995 – CONSERVATION AWARD FOR MEMBER: Jeff Harrison for his work as Chairperson of the Fletcher Wildlife Garden Committee and his co-authorship of the "Urban Naturalist" in the Ottawa Citizen.

1995 – CONSERVATION AWARD FOR NON-MEMBER: Kit Chubb and the Avian Care and Research Centre at Verona Ontario, for care and rehabilitation of injured birds.

In addition to the above awards, the President's Prize was given to Dave Smythe for his work in keeping Club records since 1991.

BILL ARTHURS

Birds Committee

The Committee continued its regular activities including the Fall Bird Count, the Ottawa-Hull

Christmas Bird Count, the Dunrobin Christmas Bird Count (a new responsibility), tending the Bird Status Line and the Rare Bird Alert. It also provided leaders for Club field trips and articles for *Trail & Landscape*.

The Committee maintained bird feeders at five locations and organized the annual Seedathon where almost \$1000 was raised to provide seed for the feeders.

The Bird Records Subcommittee was reinstated and met four times to review the list of rare bird reports.

In response to Council's request for new projects, planning was started for a birding contest for school-age children, to create and promote interest in birding and to foster field skills.

Certificates of appreciation were sent to members of the community who have given generously of their time, energy, and hospitality to Ottawa's birders.

Members of the Committee participated in the trial run of the Fletcher Wildlife Garden's Taverner Cup competition.

CHRIS TRAYNOR

Computer Management Committee

The focus of 1996 activities was on upgrading the Club's computer hardware. A high performance personal computer was purchased for use as a desktop

publishing system for *Trail & Landscape*. An existing machine will be reconfigured for the Editor of *The Canadian Field-Naturalist*, to provide access to electronic mail for communication with authors across Canada.

The Committee took advantage of the convenience and efficiency of electronic mail to conduct much of its business.

The Committee assisted in planning the eventual integration of the accounting and membership record systems, by providing technical support concerning computer software. The previous manual accounting system was moved to a computer-based package, using the existing membership records to establish the initial "customer" base for the new accounts.

ALAN GERMAN

Conservation Committee

The Conservation Committee represented the OFNC in a variety of conservation and policy issues during 1996. Members of the Committee participated in the Marlborough Forest Advisory Committee. They continued to support enhancement of the environmental policies of the Regional Municipality of Ottawa Carleton (RMOC) Official Plan through participation in focus groups such as the Wetlands Working Group and the Rural Sounding Board.

Various submissions were made by OFNC members to the Minister of Heritage, Parks Canada, the National Capital Commission, committees of the Ontario Legislature, and the Ontario Municipal Board as well as local and regional municipalities, to advocate the protection and enhancement of natural areas in the Ottawa-Hull area.

MICHAEL MURPHY

Education & Publicity Committee

The following major events were attended by members of the Club:

- Ottawa Boat & Sportsman show (first time)
- Ottawa Home Show (for Fletcher Wildlife Garden)
- Ottawa Regional Science Fair (judging)
- Environment Week (at Statistics Canada)

The first two shows generated more publicity for OFNC than any other activities to date due to the size and geographical diversity of the audience.

Of special note, were the many events held at the Fletcher Wildlife Garden Interpretive Centre, where the Committee maintains its display as part of the permanent infrastructure. The Committee also held all of its meetings there since the Spring of 1996.

TOM REEVE

Excursions & Lectures Committee

The Committee met four times during 1996, to plan 62 activities for the enjoyment and education of Club members. The schedule included eight monthly

meetings featuring a diverse array of guest speakers and topics.

Single day bus excursions were organized to Presqu'ile Provincial Park, Derby Hill Bird Observatory, the Montreal Botanical Gardens, Chaffey's Locks, Cooper Marsh (annual picnic), and Gatineau Park. A weekend outing to observe Spruce Grouse in Algonquin Park was again well received by the participants.

Two indoor workshops were conducted, one on bird identification, by sight and sound, and the other on fern identification. The balance of the program consisted of 43 full or half-day outings occurring predominantly within the Ottawa district. Only one trip had to be cancelled due to the leader's commitment to an out-of-town event.

COLIN GASKELL

Executive Committee

The Executive Committee did not meet in 1996.

DAVE MOORE

Finance Committee

The Finance Committee met three times in 1996. The main items considered were the annual accounts and budget of the Club, the treatment of the Fletcher Wildlife Garden in the Club's accounting system and a recommendation to Council concerning a donation in kind.

KEN YOUNG

Fletcher Wildlife Garden Committee

Significant improvements to the physical environment of the Garden were made this year. The model garden was completed. The sedge meadow has become an amphibian pond with an island and deep pool where eggs of four species of frogs were introduced. Two major plantings were made in the new woods. In the old woodlot, more woodland plants were brought in and some buckthorn removed. New signs were installed in various locations.

The Interpretive Centre was improved with the addition of furniture, exterior security lighting, the start of a reference library, and new exhibits. New printed material was made available including the first checklist of Butterflies of the Ottawa District. Many Council and Committee meetings were held at the Centre.

Twelve program events were conducted attracting about 1000 people. Major events included Earth Day, an Environment Fair, Migratory Birds Day, and a Butterfly Gardening workshop.

On 19 May, the Bill Holland trail was dedicated, with about 50 people including Bill's family in attendance. The first Taverner Cup competition was held on 25 May with five teams competing. It is hoped that in future years this competition will help to fund the Garden's operation.

A grant of \$2400 was received from the Friends of the Environment Foundation, and \$1000 from Consumers Gas. For its effort in developing the Garden, the Club, through the Garden, was awarded the City of Ottawa's first Environmental Achievement Award for a community based project.

JEFF HARRISON

Macoun Field Club Committee

The Committee met five times during the year to plan the weekly schedule for the children and young people who are members of the Club. Lectures and workshops conducted by local naturalists and scientists were successfully arranged, as were field and camping trips, led mainly by Committee members. The Committee is concerned by a drop in recruitment at the youngest age levels, and notes that even if this is corrected, a difficult gap will ripple through the Club's age-segregated groups in the years ahead.

ROBERT LEE

Membership Committee

The total membership paid up for 1996, was 1024, a decrease of 30 from 1995. There were 123 new members, including 56 Family, 66 Individual and 1 Life. A detailed breakdown is given below with the 1995 figures in brackets for comparison.

Four complimentary one-year memberships were presented to outstanding young participants in the Annual Science Fair.

Unfortunately, in 1996 we lost two of our Honorary members, Claude Garton, a member since 1945 and an Honorary member since 1985, and Dr. W. G. "Bill" Dore, an active member since 1932 and an Honorary member since the early 1970s.

This year we added four members to our "Golden Anniversary" membership list: Dr. N. Polunin, a Life member now living in Switzerland, and three well-known local residents, Clarrie Frankton, Jack Gillett

and Vic Solman. Again we are so fortunate to know and learn from these delightful friends.

PATRICIA NARRAWAY

Publications Committee

The Publications Committee oversees and advises on all aspects of the Club's Publications. It met twice in 1996.

Five issues of *The Canadian Field-Naturalist* (CFN) were published in 1996: Volume 109, Issues 3,4 and Volume 110, issues 1,2,3. They contained 822 pages, 32 articles, 35 notes, 10 COSEWIC articles, 82 book reviews, 278 new titles, 1 commemorative tribute, and 33 pages of News and Comments.

Volume 109, issue 3, was a special issue published in cooperation with the Missouri Botanical Garden, containing three articles: reviews of the history of the exploration of the vascular flora of Canada, Saint-Pierre and Miquelon, and Greenland, by James Pringle. Volume 110, issue 1, contains a biography of P. A. Taverner by John Cranmer-Byng entitled "A Life with Birds: Percy A. Taverner, Canadian Ornithologist, 1875-1947". Preparatory work was completed for another special issue in 1997.

All but one of the Associate Editors of the CFN, accepted reappointment in 1996. [The retired associate Diana Laubitz, invertebrates, has retired from her Emeritus position at the Canadian Museum of Nature].

Volume 30 of Trail & Landscape was published in 4 issues that contained 180 pages. Popular subjects were about birds and the Fletcher Wildlife Garden. Two of the issues were accompanied by a single page issue of the Green Line.

During 1996, the Club approved a further grant of \$1000 towards the publication of "The Butterflies of Canada" by the University of Toronto Press, authors P. Hall, D. Lafontaine, and R. Layberry. This volume is expected to appear in the early summer of 1997.

RONALD BEDFORD

Membership of The Ottawa Field-Naturalists Club, 1996.

(subscriber totals not included, see page 323).

CANADIAN			FOREIGN		Total
Type	Local	Other	USA	Other	
Family	359 (355)	22 (22)	4 (3)	0 (0)	385 (380)
Honorary	13 (14)	9 (10)	1 (1)	0 (0)	23 (25)
Individual	403 (432)	136 (135)	23 (24)	3 (4)	565 (595)
Life	15 (15)	20 (20)	4 (2)	2 (2)	41 (39)
Sustaining	9 (9)	1 (5)	0 (1)	0 (0)	10 (15)
Total	799 (825)	188 (192)	32 (31)	5 (6)	1024 (1054)

**The Ottawa Field-Naturalists' Club Financial Statement:
for the Year end 30 September, 1996**

Auditor's Report

To: The Members of THE OTTAWA FIELD-NATURALISTS' CLUB:

I have audited the balance sheet of The Ottawa Field-Naturalists' Club as at September 30, 1996, and the statements of operations and members' equity. These financial statements are the responsibility of the organization's management. My responsibility is to express an opinion on these statements based on my audit.

Except as explained in the following paragraph, I conducted my audit in accordance with generally accepted auditing standards. Those standards require that I plan and perform an audit to obtain reasonable assurance whether the financial statements are free of material misstatement. An audit includes examining evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall financial statement presentation.

In common with many non-profit organizations, The Ottawa Field-Naturalists' Club derives some of

its revenue from memberships, donations, and fund raising activities. These revenues are not readily susceptible to complete audit verification, and accordingly, my verification was limited to accounting for the amounts reflected in the records of the organization.

In my opinion, except for the effect of the adjustments, if any, which I might have determined to be necessary had I been able to satisfy myself concerning the completeness of the revenues referred to in the preceding paragraph, these financial statements present fairly, in all material respects, the financial position of the OFNC as of September 30, 1996, and the results of its operations for the year then ended in accordance with generally accepted accounting principles.

JANET M. GEHR
Chartered Accountant

North Gower, Ontario
January 11, 1997

The Ottawa Field-Naturalists' Club
Balance Sheet
September 30, 1996

	1996	1995
ASSETS		
CURRENT ASSETS		
Cash	240,662	270,404
Accounts Receivable	14,904	9,808
Interest Receivable	3,023	4,299
Prepaid Expenses.....	1,608	1,608
	260,197	286,119
FIXED (Note 3).....	0	0
LAND - Alfred Bog	3,348	3,348
	263,545	289,467
LIABILITIES, FUNDS AND MEMBERS' EQUITY		
CURRENT LIABILITIES		
Accounts Payable.....	12,418	22,800
Deferred Income	13,836	12,068
	26,254	34,868
FUNDS (Note 4).....	17,976	14,616
LIFE MEMBERSHIPS.....	7,000	6,500
CLUB RESERVES	100,000	100,000
GENERAL EQUITY	112,315	133,483
	263,545	289,467

The Ottawa Field-Naturalists' Club
Statement of Members' Equity
September 30, 1996

	1996	1995
EXCESS INCOME (EXPENDITURES)		
The Ottawa Field-Naturalists' Club	(3,070)	1,476
Canadian Field-Naturalist	(18,015)	15,126
	(21,085)	16,602
OTHER INCOME (ALLOCATIONS)		
Donations - Misc. upon membership renewal	3,551	3,503
Allocation to Kiriline-Lawrence Fund	(3,634)	(2,719)
	(83)	784
TOTAL INCOME	(21,168)	17,386
MEMBERS' EQUITY,		
Beginning of Year.....	233,483	216,097
MEMBERS' EQUITY,		
End of Year.....	212,315	233,483

The Ottawa Field-Naturalists' Club
Statement of Operations - OFNC
Year Ended September 30, 1996

	1996	1995
INCOME		
Memberships.....	14,879	14,406
T&L Subscriptions and Back Issues.....	186	503
Interest.....	2,626	3,212
Other Sales	3,268	2,885
Special Publications	366	139
Total Income	21,325	21,145
EXPENSES		
OPERATIONS EXPENSES		
Affiliation fees	2,193	2,134
Computer.....	2,295	3,397
Membership	1,677	1,702
Office assistant.....	1,012	748
Operations	3,584	3,088
OFNC GST Rebate	778	(499)
Total Operations Expenses	11,539	10,570
CLUB ACTIVITY EXPENSES (Net)		
Awards	187	0
Soiree	(191)	209
Birds.....	327	0
Conservation	280	139
Education and Publicity ...	1,337	157
Excursions and Lectures ..	(22)	(713)
Fletcher Wildlife Garden .	1,237	1,200
Macoun Club.....	968	613
Trail & Landscape.....	8,733	7,494
Total Club Activity Expenses	12,856	9,099
	24,395	19,669
EXPENSES OVER INCOME...	(3,070)	1,476

**The Ottawa Field-Naturalists' Club
Statement of Operations - CFN
Year Ended September 30, 1996**

	<u>1996</u>	<u>1995</u>
INCOME		
Memberships.....	9,878	9,699
Subscriptions.....	<u>28,821</u>	<u>25,771</u>
Sub-Total.....	38,699	35,470
Reprints.....	9,002	6,542
Publication charges.....	17,270	31,026
Back numbers.....	316	316
Interest and exchange.....	<u>12,429</u>	<u>16,485</u>
Total Income.....	<u>77,716</u>	<u>89,839</u>
EXPENSES		
Publishing.....	67,534	49,557
Reprints.....	5,306	6,495
Circulation.....	5,646	6,743
Editing.....	2,411	2,475
Office assistant.....	5,428	4,997
Office supplies.....	2,509	2,344
Advertising.....	84	145
Honoraria.....	4,500	4,500
CFN GST Rebate.....	<u>2,313</u>	<u>(2,543)</u>
	<u>95,731</u>	<u>74,713</u>
EXPENSES OVER INCOME.....	<u>(18,015)</u>	<u>15,126</u>

**The Ottawa Field-Naturalists' Club
Notes To The Financial Statements
September 30, 1996**

1. *Authority and Activities*

The Ottawa Field-Naturalists' Club is a non-profit organization incorporated under the laws of Ontario (1884). The Ottawa Field-Naturalists' Club promotes the appreciation, preservation and conservation of Canada's natural heritage; encourages investigation and publishes the results of research in all fields of natural history and diffuses information on these fields as widely as possible. It also supports and cooperates with organizations engaged in preserving, maintaining or restoring environments of high quality for living things.

2. *Significant Accounting Policies*

Membership, subscriptions and donations are recorded as received. All other revenues and expenditures except for inventory are accounted for on an accrual basis. Memberships are allocated to The Canadian Field-Naturalist publication on a predetermined percentage.

Supplies, records, tapes and other items held for resale are expensed when purchased.

Fixed assets acquired after 1989 are expensed. Fixed assets acquired prior to 1990 were recorded at cost and depreciated on a straight line basis.

3. *Fixed Assets*

	<u>1996</u>	<u>1995</u>
Cost	16,746	16,746
Accumulated Depreciation.....	<u>16,746</u>	<u>16,746</u>
Net Book Value.....	<u>0</u>	<u>0</u>

4. *Funds*

	<u>1996</u>	<u>1995</u>
Seedathon.....	964	585
Anne Hanes Memorial Fund...	870	870
de Kiriline-Lawrence Fund....	15,432	12,749
Alfred Bog	<u>451</u>	<u>412</u>
	<u>17,717</u>	<u>14,616</u>

5. *Statement of Operations - CFN*

The CFN operating deficit for the current fiscal year was a result in part of the publication, without charge, of a special issue.

The Problem of Invading Alien Trees and Shrubs: Some Observations in Ontario and a Canadian Checklist

PAUL M. CATLING

8 Scrivens Drive, R.R. #3, Metcalfe, Ontario K0A 2P0

Catling, Paul M. 1997. The problem of invading alien trees and shrubs: some observations in Ontario and a Canadian checklist. *Canadian Field-Naturalist* 111: 338–342.

A list is presented of 180 taxa (mostly species) of woody plants which have been introduced into Canada from another country, or introduced from one region of Canada to another, and have been reported as spreading in their newly colonized Canadian range. Some of these woody aliens have proven very aggressive, forming monospecific stands, displacing native plants and animals, and changing native communities, with the ultimate result being the loss of native biodiversity. The majority of the invading aliens are from Europe, with only 25 (14%) from within North America. They were introduced and distributed for varying reasons including use as ornamentals, crops, wildlife enhancement plants, and sources of fibre and drugs. Effective management requires both taxonomic, phytogeographic and ecological data. Strict restrictions on entry and commerce and biological controls are all important considerations. A more widespread appreciation of the problem is a fundamental need.

Key Words: Biodiversity, aliens, invasions, weeds, trees, shrubs, Canada.

Some people have speculated that introduced species are the greatest threat to global biodiversity. "Even if the destruction of natural habitats such as rain forests and wetlands ceased tomorrow, the insidious effects of introduced species would continue to erode the world's biodiversity" (Clout 1995). In Canada, alien invaders of natural habitats, such as Purple Loosestrife (*Lythrum salicaria*; see Mal et al. 1992), have recently emerged as a new and very conspicuous class of weeds that form dense monospecific stands displacing native plants and animals and changing native communities, with the ultimate result being the loss of native biodiversity (ecotypes, species and communities). Of course, they have been present for a long time, but their harmful effects are now becoming more obvious. Unlike the traditional weeds of row crops, pastures and lawns, which are mostly herbaceous plants, this newly defined group includes a significant proportion of trees and shrubs. A recent survey (White et al. 1993), prepared under contract to the Canadian Wildlife Service, identified 55 important invasive aliens of natural habitats, of which 18 (32%) were woody plants. The buckthorns were listed among the four principal invasive aliens of uplands, and Glossy Buckthorn (*Rhamnus frangula*, see also Catling and Porebski 1995) was rated as one of the six principal invasive aliens of native wetlands. How many of these invading woody aliens are there in Canada and what are they? What kinds of problems are associated with them? Is our state of knowledge adequate to cope with the problems? The following observations and checklist respond to these and related questions.

Problems

Aerial photography and mapping of woodlands in some urban (and some not so urban) areas of south-

ern Ontario may suggest some impressive forest remnants, and a claim that a certain portion of the landscape is "natural". A closer look, however, may reveal that the forests are not dominated by Sugar Maple, but the European Norway Maple, or that underneath a canopy of native trees is a thicket of alien shrubs beneath which nothing else can grow. A lack of understanding of the impact of alien trees and shrubs can result in inappropriate assumptions about forest quality. Such a lack of understanding has even resulted in field surveys that have mistaken a forest of aliens for a native forest!

The extent of woody alien domination in many urban situations in southern Ontario has led some biologists and planners to consider abandoning biodiversity protection within cities. However, special features of urban areas, like nutrient inputs, relatively high disturbance levels, pollution, and/or relatively heavy "seed rain" of cultivated species, do not appear to limit alien invasion. In fact, some invasions appear to begin in urban centres and then move out into rural areas (Catling and Porebski 1995).

Despite a great deal of attention that has been focussed on old growth woodlands and wetlands, some of the most serious problems in protecting native biodiversity in eastern North America centre on the decline of dry to mesic open habitats due to both control of fires and natural succession to woody growth. Aliens have sometimes played a major role here in invading openings more quickly, and aggressively dominating them more completely, than would any native woody plant. European Buckthorn (*Rhamnus cathartica*) is an example of a woody alien that has become very common over large portions of the southern Ontario landscape and should be a major concern with regard to protection of native biodiversity.

The contributions of conservationists and wildlife managers to the problems with invading aliens is a source of embarrassment. To appreciate the problem, one need only consider the planting of Scots Pine (*Pinus sylvestris*) in native open habitats that have become thoroughly choked with this aggressive weed tree. Plantings of Multiflora Rose (*Rosa multiflora*), Honeysuckles (*Lonicera* spp.), and Autumn-Olive (*Elaeagnus umbellata*) in the name of "wildlife enhancement" have contributed a great deal to invading alien problems. In many cases, the damage may have been done without much improvement in either conservation or wildlife enhancement. There is little evidence that exotics are generally superior to native species (e.g., Harty 1986).

Invading woody aliens are not only a threat to the biodiversity of natural ecosystems; some influence Canadian economy in more direct ways. With regard to agriculture, some of the most serious invaders of natural ecosystems in eastern Canada, the buckthorns, are directly relevant as major alternate hosts of pests, such as the aphids on potato crops, and pathogens such as rusts on cereal crops. These buckthorns are covered by provincial weed acts in three provinces. Other invading woody plants are utilized as crops, as food and cover for wildlife, were developed for horticultural purposes, are planted for soil improvement, erosion control, or as windbreaks. Their naturalization is the cost of their use for these various purposes, and represents an impact of wildlife management, agriculture or horticulture, etc., on Canadian biodiversity. Biodiversity threatened by woody invasive aliens includes native germplasm resources and potential biocontrol agents.

Inadequacy of Information

With recent literature and herbarium collection data, the list of taxa of alien trees and shrubs spreading in Canada was increased by 96 species out of a total of 168. Over half of these spreading aliens are rare or local. However, the two texts providing the basic list are relatively recent (1966–1997, 1978–1979) suggesting that alien trees and shrubs have been neglected by botanists. It is unlikely that the number of native plants, crop relatives, or weeds directly impacting upon row crops, in these works could be increased by more than 50%. How can one requiring accurate data be confident of the information and identification when the text used is known to be lacking more than 50% of the possibilities, even if the likeliest possibilities are included?

A few recent manuals (e.g., Hinds 1986) treat woody invasive aliens comprehensively, but the specialized weed and woody plant literature provides a remarkable contrast. The only woody plant in most weed books was poison ivy. Various books featuring trees and/or shrubs have at least some deficiencies in terms of inadequate coverage. The most recent manu-

al of Canadian trees (Farrar 1995) for example, helps much more than its predecessors because it includes introduced and naturalized (spreading) species, but often with relatively little information compared to that provided for the native species covered. Despite numerous references to the value of various trees, and often minor values such as ornaments and carving, the problems associated with invading alien tree species in Canada are not well presented.

It appears that the environment, wildlife, systematics and ecology related sectors have the most complete understanding of the problems associated with invading alien trees and shrubs. Those traditionally (and most) concerned with weeds (i.e., the agricultural sector), and those most concerned with woody plants (i.e., the forestry and horticultural sectors), appear to have a less complete understanding. Certainly, the available literature provides some of the explanation for this. Although the systematics and ecology sectors may be the most logical ones to deal with the problem, the agriculture and forestry sectors, in particular, have potentially important roles, especially in relation to management and control.

Solutions

Analysis of the list (Table 1) provides some useful perspectives on management. Since the majority of species on the list are cultivated plants, there are possibilities for some control through consideration of alternative utilization of native species or of use of less aggressive cultivars. Some outstanding examples of the substitution of native species for exotics in wildlife enhancement are now available (e.g., Harty 1986). The majority of species on the list, and the most serious problem species, are Eurasian, and are more or less without close relatives in Canada. This suggests that it is likely that the problems of dominance could be a consequence of lack of natural enemies in Canada, and this in turn leads to the optimistic conclusion that biocontrol agents may be found and introduced to effectively deal with the problem. Consideration of aliens as "guilty until proven innocent" (i.e., keeping all nonindigenous species out of the country until they are demonstrated to be safe, Ruesink et al. 1995) appears to be a very sensible approach.

Management of invading alien woody plants requires both accurate and efficient means of identification and biological information. Trees and shrubs are not as well known as many people think. If they were, it would not have been possible to add four new species to the native trees of Ontario over the past 10 years. Even basic taxonomic work is inadequate. For example, the classification of some groups such as the taxa of *Rubus* requires more study. The hybrids of the alien *Betula pendula* invading open habitats in the lower Ottawa valley, including a wetland recently designated as signifi-

cant on a worldwide scale, also require further study to enable accurate identification. European Buckthorn has two close Asian relatives (*R. davurica* and *R. utilis*) and is itself rather variable. Although the potential for effective biocontrol has been identified, a sound basis for it is lacking until a field survey and taxonomic research can determine authoritatively the origin and identity of the plants that have become a major component of the vegetation of much of the eastern Canadian landscape. Information on effects of alien woody plants on the natural ecosystem is largely limited to anecdotal observations and assumptions, instead of data. The assembly and review of biological information required for effective management is at most preliminary. Although a small proportion of the spreading alien woody plants have serious impacts on native biodiversity, their impacts are rapidly increasing and, it may be appropriate to deal with small problems before they turn into much larger ones and the damage is done. Probably the greatest obstacle to effective solutions however, is the lack of a more widespread appreciation of the problem, and access to satisfactory information.

The Checklist (Appendix 1)

A preliminary list of alien trees and shrubs growing in Canada without cultivation was prepared using Boivin (1966-1967) and Scoggan (1978-1979), and this was expanded through a survey of other more recent literature (e.g., Anderson 1988; Douglas et al. 1989-1994; Hinds 1986) and herbarium collection data. "Alien" plants are those species established in parts of Canada beyond their native ranges. "Invading" refers to the fact that these plants are increasing (to a greater or lesser extent) in both number of individuals and area covered through natural (unaided by humans) reproduction and dispersal. A species was included if there was any report or evidence of natural reproduction or spread, even if the evidence was weak (as for *Maclura pomifera*, for which, however, there are a number of reports of escape in Michigan). Slightly shrubby (suffrutescent) species such as the perennial, decumbent, Tree Lupine (*Lupinus arboreus* Sims), naturalized on southern Vancouver Island, are not included.

The current list includes 180 taxa (mostly species). Some not included in identification keys in Canadian literature are included in texts covering the United States (Gleason and Cronquist 1991), and many are included in Bailey's (1954) manual of cultivated plants. The majority of the species on the list are in southern Ontario and/or southern British Columbia. Most are introduced from Europe, with only 25 (14%) from within North America (either from the United States, such as *Robinia pseudoacacia* or from one part of Canada to another, such as *Rubus allegheniensis* and *Vaccinium corymbosum* introduced to British Columbia from eastern Canada). Although the

native North American species are fewer, some have been identified as problems (*Acer negundo*, *Robinia hispida*). The Pea family contains more invading North American natives than any other family. Some of the invasive North American natives are remarkable when one considers their distant and restricted native ranges (e.g., *Catalpa bignonioides*, *Maclura pomifera*, *Robinia viscosa*).

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Appendix 1.

List of invading trees and shrubs in Canada, including both native North American species (preceded by "+") introduced and spreading beyond their native range in

Canada, and alien species (from outside North America), based on Boivin (1966-1967) and Scoggan (1978-1979) as well as consideration of more recent literature and herbarium specimens. The list is intended to include all species for which there is some evidence of introduction and natural spread. Asterisks (*) indicate invasive aliens of natural habitats identified by White et al. (1993).

PINACEAE

- Larix decidua* Mill., EUROPEAN LARCH
- Picea abies* (L.) Karst., NORWAY SPRUCE
- **Pinus sylvestris* L., SCOTS PINE
- Pinus mugo* Turra, MUGHO PINE
- Pinus nigra* Arnold, AUSTRIAN PINE
- Pinus virginiana* Miller, SCRUB PINE

SALICACEAE

- Populus alba* L., WHITE POPLAR
- Populus* × *berolinensis* (Regel) Dippel (*P. nigra* var. *italica* × *laurifolia*)
- Populus* × *canadensis* (*P. deltoides* × *nigra*), CAROLINA POPLAR
- Populus* × *canescens* (Aiton) Smith (*P. alba* × *tremula*)
- +*Populus deltoides* Bartr. ex Marsh (including the western ssp. *monilifera* (Ait.) Eckenw. and the eastern ssp. *deltoides* and intermediates), COTTONWOOD
- Populus* × *heimburgeri* B. Boivin (*P. alba* × *tremuloides*)
- Populus nigra* L., BLACK POPLAR (including the Lombardy Poplar, var. *italica* Du Roi)
- Salix alba* L., WHITE WILLOW (including var. *alba* with silky-hairy branchlets, var. *calva* Mey. with brown glabrate branchlets, and var. *vitellina* Stokes with yellow glabrate branchlets)
- Salix capraea* L., GOAT WILLOW
- Salix cinerea* L., GREY WILLOW
- Salix daphnoides* Villars, WILLOW
- Salix elaeagnos* Scop., WILLOW
- Salix fragilis* L., CRACK-WILLOW
- Salix* × *jesupii* Fern. (*S. alba* × *lucida*), JESUP'S WILLOW
- Salix myrsinifolia* Sal. (*S. nigricans*), WILLOW
- Salix* × *pendulina* Wenderoth (*S. babylonica* × *fragilis*), WILLOW
- Salix pentandra* L., BAY-LEAVED WILLOW
- Salix* × *rubens* Schrank (*S. alba* × *fragilis*), WILLOW
- Salix* × *sepulcralis* Simonkai (*S. alba* var. *vitellina* × *babylonica*), WEEPING WILLOW
- Salix purpurea* L., BASKET-WILLOW
- Salix viminalis* L., OSIER WILLOW

MYRICACEAE

- +*Myrica californica* C. and S., WAX MYRTLE

BETULACEAE

- **Alnus glutinosa* (L.) Gaertn., BLACK ALDER
- Betula alba* L. (*B. pubescens*), EUROPEAN WHITE BIRCH
- **Betula pendula* Roth., EUROPEAN BIRCH

FAGACEAE

- Quercus robur* L., ENGLISH OAK

ULMACEAE

- Ulmus glabra* Huds., WYCH ELM
- Ulmus procera* Salisb., ENGLISH ELM
- Ulmus pumila* L., SIBERIAN ELM

MORACEAE

- +*Maclura pomifera* (Raf.) Schneid., OSAGE ORANGE
- **Morus alba* L., WHITE MULBERRY

CANNABINACEAE

- Humulus lupulus* L. var. *lupulus*, HOP

BERBERIDACEAE

- Berberis thunbergii* DC., JAPANESE BARBERRY
- Berberis vulgaris* L., COMMON BARBERRY
- Berberis* × *ottawensis* Schneid., HYBRIDE × BARBERRY
- +*Mahonia repens* (Lindley) G. Don, MAHONIA

GROSSULARIACEAE

- Philadelphus coronarius* L., MOCK-ORANGE
- Philadelphus inodorus* L., MOCK-ORANGE
- Philadelphus pubescens* Loisel, MOCK-ORANGE
- Ribes diacanthum* Pallas, SIBERIAN CURRANT
- Ribes grossularia* L., GOOSEBERRY
- +*Ribes missouriense* Nutt., MISSOURI GOOSEBERRY
- Ribes nigrum* L., BLACK CURRANT
- +*Ribes odoratum* Wendland f., BUFFALO CURRANT
- Ribes rubrum* L. (*R. sylvestre*, *R. sativum*), EUROPEAN RED CURRANT
- Ribes uva-crispa* L., GARDEN GOOSEBERRY

ROSACEAE

- +*Aruncus dioicus* (Walter) Fern., GOAT'S BEARD
- Cotoneaster acutifolia* Turcz., COTONEASTER
- Cotoneaster bullatus* Boiss., BULLATE-LEAVED COTONEASTER
- Cotoneaster horizontalis* Decne., CREEPING COTONEASTER
- Cotoneaster melanocarpa* Lodd., COTONEASTER
- Cotoneaster simonsii* Bak., SIMON'S COTONEASTER
- Crataegus laevigata* (Poiret) DC. (*C. oxyacantha*), ENGLISH HAWTHORN
- Crataegus monogyna* Jacq., ENGLISH HAWTHORN
- Cydonia oblonga* Miller (*Pyrus cydonia*), QUINCE
- Malus baccata* L., SIBERIAN CRAB
- Malus pumila* Miller (*M. sylvestris*, *Pyrus malus*), APPLE
- Malus prunifolia* Willd., CHINESE APPLE
- Prunus avium* L., SWEET CHERRY
- Prunus cerasifera* Ehrh., CHERRY PLUM
- Prunus cerasus* L., SOUR CHERRY
- Prunus domestica* L., DAMSON PLUM (including var. *domestica* with slightly pubescent or glabrous twigs and var. *insititia* (L.) Poir. with densely pubescent twigs)
- Prunus laurocerasus* L., CHERRY-LAUREL
- Prunus mahaleb* L., MAHALEB CHERRY
- Prunus padus* L., EUROPEAN BIRD-CHERRY
- Prunus persica* (L.) Batsch, PEACH
- Prunus spinosa* L., SLOE
- Prunus tomentosa* Thunb., MANCHU CHERRY
- Pyrus communis* L., PEAR
- Rosa canina* L. var. *canina*, DOG-ROSE
- Rosa centifolia* L., CABBAGE-ROSE
- Rosa cinnamomea* L., CINNAMON ROSE
- Rosa eglanteria* L., SWEET-BRIER
- Rosa hugonis* Hemsley, HUGO ROSE
- Rosa micrantha* J. E. Smith, ROSE
- **Rosa multiflora* Thunb., MULTIFLORA-ROSE
- Rosa odorata* Sweet, TEA-ROSE
- Rosa pumpinellifolia* L., ROSE
- Rosa rubiginosa* L., ROSE (possibly better combined with *R. eglanteria*)
- Rosa rugosa* Thunb., JAPANESE ROSE
- Rosa spinosissima* L., BURNET-ROSE
- Rosa tomentosa* Sm., DOWNY ROSE
- +*Rubus allegheniensis* T. C. Porter, ALLEGHENY BLACKBERRY
- Rubus caesius* L., EUROPEAN DEWBERRY

- **Rubus discolor* Weihe and Nees (*R. procerus*),
HIMALAYAN BLACKBERRY
Rubus idaeus L. var. *idaeus*, RASPBERRY
Rubus illecebrosus Focke, STRAWBERRY-RASPBERRY
Rubus laciniatus Willd., EVERGREEN BLACKBERRY
Sorbaria sorbifolia (L.) A. Br., FALSE SPIRAEA
Sorbus aucuparia L., EUROPEAN MOUNTAIN-ASH
Spiraea chamaedryfolia L., SPIRAEA
Spiraea corymbosa Raf., SPIRAEA
Spiraea japonica L. f., JAPANESE SPIRAEA
Spiraea salicifolia L., SPIRAEA
Spiraea thunbergii Siebold ex Blume, THUNBERG'S SPIRAEA
- FABACEAE
+*Amorpha fruticosa* L. var. *fruticosa*, FALSE INDIGO
**Caragana arborescens* Lam., CARAGANA
Caragana frutex (L.) Koch, RUSSIAN PEA-SHRUB
+*Cladrastis kentuckea* (Dum.-Cors.) Rudd. (*C. lutea*),
YELLOW-WOOD
Colutea arborescens L., BLADDER SENNA
**Cytisus monspessulanus* L., BROOM
Cytisus scoparius (L.) Link, SCOTCH BROOM
+*Gleditsia triacanthos* L., HONEY-LOCUST
Genista tinctoria L., DYER'S GREENWEED
Laburnum anagyroides Medic., GOLDEN CHAIN TREE
+**Robinia hispida* L., BRISTLY LOCUST
+*Robinia luxurians* (Dieck) Schneid., LOCUST
+*Robinia pseudo-acacia* L., BLACK LOCUST
+*Robinia viscosa* Vent., CLAMMY LOCUST
Ulex europaeus L., GORSE
- RUTACEAE
Ruta graveolens L., RUE
- SIMAROUBACEAE
Ailanthus altissima (Mill.) Swingle, TREE-OF-HEAVEN
- AQUIFOLIACEAE
Ilex aquifolium L., ENGLISH HOLLY
- CELASTRACEAE
Celastrus orbiculatus Thunb., ORIENTAL BITTERSWEET
Euonymus alata (Thunb. Siebold, SPINDLE-TREE
Euonymus europaea L., SPINDLE-TREE
Euonymus fortunei (Turcz.) Hand.-Mazz., SPINDLE-TREE
- ACERACEAE
Acer ginnala Maxim. (*A. tatarica* L.), AMUR MAPLE
+**Acer negundo* L., MANITOBA MAPLE (including var.
interius (Britt.) Sarg. with velvety-pubescent twigs and
var. *negundo* with glabrous twigs)
**Acer platanoides* L., NORWAY MAPLE
Acer pseudo-platanus L., SYCAMORE MAPLE
- HIPPOCASTANACEAE
Aesculus hippocastanum L., HORSE-CHESTNUT
+*Aesculus glabra* Willd., OHIO BUCKEYE
- RHAMNACEAE
**Rhamnus cathartica* L., COMMON BUCKTHORN
Rhamnus davurica Pall., BUCKTHORN
**Rhamnus frangula* L., GLOSSY BUCKTHORN
- TILIACEAE
Tilia cordata Miller, SMALL-LEAVED LINDEN
+*Tilia heterophylla* Vent., WHITE BASSWOOD
Tilia × vulgaris Hayne (*T. cordata* × *platyphyllos*),
LINDEN

- MALVACEAE
Lavatera thuringiaca L., TREE-MALLOW
Lavatera trimestris L., TREE-MALLOW
- THYMELAEACEAE
Daphne mezereum L., DAPHNE
- ELAEAGNACEAE
Elaeagnus angustifolia L., RUSSIAN OLIVE
Elaeagnus umbellata Thunb., AUTUMN-OLIVE
Hippophae rhamnoides L., SEA-BUCKTHORN
- ONAGRACEAE
+*Calylophus serrulatus* (Nutt.) Raven, SHRUBBY EVENING
PRIMROSE
- ARALIACEAE
Aralia spinosa L. (or more likely *A. elata* (Miq.) See.) ,
DEVIL'S-WALKING-STICK
**Hedera helix* L., ENGLISH IVY
- ERICACEAE
Calluna vulgaris (L.) Hull, HEATHER
+*Vaccinium corymbosum* L., HIGHBUSH BLUEBERRY
- OLEACEAE
Fraxinus excelsior L., EUROPEAN ASH
Ligustrum vulgare L., PRIVET
**Syringa vulgaris* L., LILAC
- APOCYNACEAE
Vinca major L., LARGE PERIWINKLE
**Vinca minor* L., COMMON PERIWINKLE
- SOLANACEAE
Lycium barbarum L. (*L. halimifolium*), MATRIMONY-VINE
Lycium chinense Miller
Solanum dulcamara L., NIGHTSHADE
- BIGNONIACEAE
+*Catalpa bignonioides* Walt., CATALPA
- CAPRIFOLIACEAE
Lonicera × bella Zabel, (*L. morrowii* × *tatarica*), PRETTY
HONEYSUCKLE
Lonicera caprifolium L., WOODBINE
Lonicera chrysantha Turcz., HONEYSUCKLE
Lonicera etrusca Santi, ETRUSCAN HONEYSUCKLE
Lonicera japonica Thunb., JAPANESE HONEYSUCKLE
Lonicera maackii (Rupr.) Maxim., MAACK'S
HONEYSUCKLE
Lonicera morrowii Gray, MORROW'S HONEYSUCKLE
Lonicera × notha Zabel., NOTHA HONEYSUCKLE
Lonicera periclymenum L., WOODBINE HONEYSUCKLE
+*Lonicera prolifera* (Kirchn.) Rehd., GRAPE- HONEYSUCKLE
+*Lonicera sempervirens* L., TRUMPET-HONEYSUCKLE
**Lonicera tatarica* L., TATARIAN HONEYSUCKLE
Lonicera xylosteum L., HONEYSUCKLE
Sambucus ebulus L., DWARF ELDER
Sambucus nigra L., EUROPEAN ELDER
+*Symphoricarpos orbiculatus* Moench, INDIAN-CURRENT
Viburnum lantana L., WAYFARING TREE
Viburnum opulus L. var. *opulus*, GUELDER-ROSE
- ASTERACEAE
+*Iva frutescens* L. var. *oraria* (Bartlett) Fern and Griscom,
MARSH-ELDER

Excluded

Salix babylonica L., WEeping WILLOW (most reports of this are likely referable to *S. × sepulcralis* Simonk. (*S. alba* var. *vitellina* × *babylonica*, see Meikle 1985)

Book Reviews

ZOOLOGY

The Minds of Birds

By Alexander F. Skutch, with line drawings by Dana Gardner. 1996. Texas A&M University Press, College Station. 200 pp., illus. U.S. \$29.95.

A book by Alexander Skutch is always a delight to read. With years of meticulous and intimate observation of an avifauna that most of us can only experience in brief, tantalising glimpses, his perspective is a highly individual one. He is at his best when describing those observations, but in this book he tackles a larger and very challenging topic, the workings of birds' minds. Like his other books, this volume is full of anecdotal accounts of bird behaviour, many drawn from the literature and some from his own observations. These have been selected to provide an overview of the enormous range of activities that birds are capable of, and by inference, to provide insight into their mental abilities.

His thesis is that birds are far less stupid than most people think. He suggests that they are "feeling creatures whose own capacity for enjoyment increases the total value of life on Earth", and argues in favour of a certain amount of anthropomorphism in interpreting animal behaviour. There are 17 chapters, dealing with various aspects of birds' mental abilities: these include Emotions, Play, Aesthetic Sense, Mental Conflicts, Intelligent Birds, and Apparently Stupid Behaviour. And indeed, many of the anecdotes do suggest "intelligence" and consciously purposeful behaviour, as with the Blue Jay that tore a strip of paper from the floor of its cage and used it to poke between the bars to bring food in the adjoining cage within reach. Skutch favours such anecdotal evidence, as he feels that structured experiments often remove the element of spontaneity that may reveal the capacity for original thought in a bird.

The difficulty with all this is that the real objections to anthropomorphism in the first place were that it sometimes led to conclusions that more careful analysis revealed to be wrong. There is certainly a case to be made for interpretations being too mecha-

nistic (although perhaps more formerly than today), but even on Skutch's own terms I had difficulty with some of his arguments. To give one example, if through sexual selection birds have evolved an aesthetic sense akin to our own, as he postulates, how does one account for such aesthetically unprepossessing species as crows? To say that crows are aesthetically pleasing to other crows would seem to destroy the rest of the argument, and to argue that crows lack aesthetic sense just as some persons do, sidesteps the issue, even if it is legitimate to compare differences between individuals of a species with differences between species. Surely birds are a world of their own, in the last analysis unknowable in the human terms that Skutch espouses. He mounts an eloquent case for birds as intelligent, purposeful beings, but I suspect his views on such matters will be unlikely to convince anyone who is not already convinced.

This, then, is not a book for the ornithologist seeking an analysis of the latest in research on birds' mental capacities, and those who view their birds in these rigorous terms could well find it irritating. For the rest of us, Skutch has provided a concise summary of birds' abilities and of the incredible variety of their behaviours, and in this he has succeeded admirably. Anyone looking for a readable and thought-provoking overview of birds' abilities should find it fascinating. Indeed, even the skeptic might well be impressed by this concise picture of the entire rich tapestry of bird behaviour. You may not always agree with the author's views but they are always stimulating, and provide a balance to the rather mechanistic views of bird behaviour that prevail elsewhere. Skutch has unique insights into these fascinating creatures that delight and intrigue so many of us, and his ideas deserve thoughtful consideration.

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Martens, Sables, and Fishers: Biology and Conservation

Edited by S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell. 1994. Comstock Publishing Associates, Cornell University Press, Ithaca, New York. 484 pp., illus. U.S. \$65.00

Never before has such a synthesis of available information and current research been compiled for

the genus *Martes*. As stated in the book's preface, the objectives of the editors were to provide a comprehensive review of our current knowledge of martens, sables, and fishers; identify areas where information is lacking; and suggest areas for additional research. The authors have unequivocally met these objectives.

This book is an extension of the "Symposium on the biology and management of martens and fishers" held in Laramie, Wyoming, in 1991. All but three of the chapters were based on presentations made at this symposium. Although only one third of the presentations appear as chapters, those that do represent a comprehensive cross-section of *Martes* biology and conservation.

Martens, Sables, and Fishers consists of an introductory chapter followed by an additional 29 chapters divided into seven major parts. These parts include evolution and biogeography, population ecology, management of populations, status and conservation of Holarctic *Martes*, habitat ecology, managed habitats, and physiology and reproduction. Several of the chapters emphasize original research although the majority are comprehensive reviews of the chosen topic. Use of tables and figures is not

excessive and augments the text well. The book contains an incredibly comprehensive bibliography and a functional index.

This book is not for the casual reader; rather, it is a scientific treatise of our current knowledge of *Martes*. Contributors to this holistic treatment represent a group of dedicated wildlife biologists, many who have devoted much of their career to study this group of carnivores. *Martens, Sables, and Fishers* will surely become a classic reference because of its broad appeal to a variety of individuals with interests in wildlife biology and forest ecology.

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Chickadees, Tits, Nuthatches & Treecreepers

By Simon Harrap and David Quinn. 1995. Princeton University Press, Princeton, New Jersey. 464 pp., illus. \$49.50.

Each new volume that treats a worldwide group of birds following the "Harrison" style (Harrison 1983) seems to rise a notch in quality over its predecessors. This latest contribution is no exception. The text is scholarly and the art work first rate. It covers all the species and subspecies of the world's chickadees (or tits), true nuthatches, treecreepers, and the Wallcreeper.

A couple of weeks ago I suggested to a friend that the Black-capped Chickadee was truly a Canadian bird. It is always cheerful, gets along well with others, withstands heat or cold, is always friendly, and is generally ignored - truly a Canadian! This impish little bird and its cousins are ignored no more; they have a book of their own.

My first impression flipping through the book was how many of the species are similar. The Black-capped Chickadee has close relatives in the Marsh, Sombre, Caspian, Willow, and Songer tits and Carolina Chickadee. These are all small, perky black, grey and white birds with a strong superficial resemblance. True, they differ in fine points of plumage, song, behaviour, and sometimes in distribution. Often the extremes of differences in a single species (i.e., the subspecies) are more substantial than between separate species. To keep this problem in proper perspective, it is essential for the user to read the author's notes on splitting, lumping, subspecies, and superspecies before consulting the species accounts. Hybrids also occur and are dealt with by the author, including an illustration if appropriate.

The book covers 110 species in a series of very thorough species accounts. Each account follows the now-standard format of identification, sex/age, voice, distribution, habitat population habits, biology, description, moult, geographical variation, relationships, and references used. This generally results in an exhaustive and detailed narrative for the widespread and well known species. The text is less detailed for the few species that are range- or politically-isolated. In general, this group of birds is widespread and relatively common. Only a few species (or are they subspecies?) are rare and these are in remote and less accessible areas. For example, the White-browed Nuthatch is endemic to Mount Victoria, Myamar (Burma). Is this a geographical variation of the common White-tailed Nuthatch of the adjacent Himalayas? Is it more widespread than previously thought? These are difficult questions to research in a politically repressive region. Each species has a range map, with additional detailed maps added to the text, if warranted. A small, but in my opinion an important item, included by the author is an explanation of the terms used to describe colour. I long ago learnt that others use very different words from me to describe a specific shade of colour. In this instance the most different use of words is for "flesh" - described by the author as the colour of raw salmon.

The text is supported with illustrations by David Quinn, one of the artists who illustrated the recent "Warblers" volume (Curson et al. 1994). It is difficult for me to believe that the over 500 full representations and numerous head, tail, and flight details can be bettered. He has captured the 'jizz' correctly, provided anatomical precision and maintained a lively

artistic feeling. While I have been impressed by the art work in many recent books I think Quinn has that extra-something that makes him the new Archibald Thorburn (Thorburn was the outstanding illustrator of wildlife in Europe in the 1900s). My only surprise was Quinn’s positioning of Coal and Spot-winged Tits on the plate. I would have thought it advisable to have at least one or two heads turned to show the distinctive head (or nuchal) spot. This feature is present but is difficult to discern without close inspection.

This book is a fine addition to the enthusiastic birder’s library and should solve many gift problems. Backyard feeder watchers should also consider buying it as a reference to those species that are the most reliable of our small bird companions. Whether a fanatic or casual observer the purchaser will derive much insight and, certainly, tremendous pleasure in

owning this fine new book. For me it has raised some new challenges. In future, I will be trying to sex nuthatches and, in the appropriate locations, I will be looking for hybrid chickadees. It has also reminded me of my failure to date to find a Wall-creeper in Europe, something I must rectify soon.

References

Harrison, Peter. 1983. Seabirds - an identification guide. Houghton Mifflin Company, Boston. 448 pages.
Curson, J., D. Quinn, and D. Beadle. 1994. Warblers of the Americas. Houghton Mifflin Company, Boston. 252 pages.

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Larvae of the North American Caddisfly Genera (Trichoptera)

By Wiggins, Glenn B. 1996. 2nd edition. University of Toronto Press, Toronto. 457 pp., illus. \$110.00.

The text of the second edition has been virtually rewritten with very few paragraphs remaining unchanged from the 1977 edition, although the same general style is retained, as well as the original illustrations.

The classification (pp. 8–13) is based on phylogenetic evidence, whereas the families and genera are arranged alphabetically, consequently the page references given appear to be “jumbled”. The Trichoptera are currently divided into three suborders and six superfamilies. Eight families and 13 genera are added. The arrangement of families and genera may be objectional to some readers, however, as pointed out in the Introduction, this book is primarily a reference work.

In general, for each genus, there is a page of text giving distribution and species (general distribution

and number of species worldwide and for North America), morphology, case or retreat, biology, and remarks. On the opposite page are excellent drawings of the mature larva, dorsum of head and thorax, legs, anal leg, case if applicable, etc. It is gratifying to read that of the 149 genera recognized in North America, the larvae of at least one species are known for all but four genera.

The number of references has nearly doubled, which is indicative of activity among caddisfly workers. This, plus the fact that eight families and 13 genera are added, validates the need for this revision. The book is highly recommended and is worth the price.

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The Scientific Basis for Conserving Forest Carnivores: American Marten, Fisher, Lynx, and Wolverine in the Western United States

Edited by Leonard F. Ruggeriero, Keith B. Aubrey, Steven W. Buskirk, L. Jack Lyon, and William J. Zielinski. 1994. General Technical Report RM-254. Fort Collins, Colorado, U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. 184 pp. + map.

The reason for this compilation of information is to assess the scientific basis for conservation of forest carnivores. Extensive literature reviews for each of the four species are presented with a discussion of man-

agement considerations and information needs. The literature reviews for each species are sufficiently readable to provide even lay readers with exciting general information and yet sufficiently thorough to provide scientists with useful detail and outlines of the available data. Although the geographical focus of this book is the northwest states, much of the information is reasonably transferable to other parts of their ranges.

One of the most important features of this volume are the list of literature cited in each of the chapters.

The writers of the species' accounts have impressive credentials and have done standout service in gathering extensive detailed information, much of it from obscure and unpublished sources.

The scientists involved in the evaluation of the scientific information found, not surprisingly, that there are "substantial gaps" in the knowledge necessary for assessing conservation status. For example, they recognize that the much of what we know about the Wolverine or Lynx is largely based on studies conducted in Canada or Alaska. The authors caution readers that other weaknesses in the current information include high variability in the data, unreliability, and the difficulty and expense of research. As a result, the useful knowledge base for developing the conservation strategies for forest carnivores is extremely limited.

Following the species accounts, the authors have included a chapter on the scientific basis for conserving forest carnivores and another on information needs and a research strategy, all designed to prevent the decline of their populations. The appendices include distribution maps for each species in the northwest from 1961 to 1982 and from 1983 to 1993, and a brief review of a system to gather data on forest carnivores in National Forest system lands.

The authors recognize the paramount importance of habitat quality in regulating the populations of forest carnivores. They conclude that mesic late-successional forest stands are vital in forest carnivore conservation. They further emphasize some of the more pressing research needs, including dispersal and migration and the effect on them of habitat quality and landscape. One of the most important characteristics of these forest carnivores is the large geographic area

over which they range, although little is known about it. The authors would like to see more research on how habitat is saturated with home ranges, how these vary within the sexes of the animal, and how home ranges and habitat attributes are related.

There are also political and legal complications to this scientific situation. A story in the 18 February 1996 *Los Angeles Times* noted that a number of environmental and animal-protection groups have sued the U.S. Fish and Wildlife Service and Department of the Interior for refusing to add the Lynx to the Endangered Species List. Environmentalists contend that senior Fish and Wildlife Service and Department of the Interior officials are refusing to list it as a means of avoiding the hassle this might trigger from conservative lawmakers from the west. Senior officials and the Washington headquarters claimed that "there was a lack of conclusive evidence of biological vulnerability or real threats to the species in the contiguous 48 states." The Wolverine and Fisher have also been recommended for listing under the Endangered Species Act.

In any case, the authors have done a commendable job to make clear the absolute necessity of continuing studies of rare forest carnivores. Effective conservation strategies for them will be needed to insure their persistence. We need to hope that measures such as these will be successful.

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The Last Panda

By George B. Schaller. 1993. University of Chicago Press, Chicago. 291 pp. U.S. \$13.95.

For some people, learning about high-profile conservation and rescue operations can produce feelings of comfort and relief: Someone is Saving a Species from Extinction. These projects can soothe the conscience of those not directly involved, and many of them contribute financially to worthwhile conservation projects.

The glamour projects which pull in substantial contributions tend to be those involving the attractive, probably cuddly, and photogenic species, a description the panda fulfills to a T.

"...but the panda is one of those endangered species which can be a symbol to change our concept of ourselves, a new design in the strategy of human survival" (page xvi).

China would seem to have devoted considerable resources to protect its appealing pandas, and vast sums of money and resources have been poured into the projects by China and by wildlife organizations, primarily World Wildlife Fund (WWF), and the New York Zoological Society (NYZS). George Schaller, Director of the NYZS Conservation Division, was appointed by WWF to head the panda project in 1980. Schaller has already written *The Great Pandas of Wolong* describing the initial scientific investigation. This present account is largely about the behind-the-scenes political and financial ramifications which dominated the project and which left the panda's welfare lagging far down the priority list. He is a good writer, and by the words he chooses conveys far more than what is actually written. He does describe some of his own field surveys which contributed to the WWF Plan for Panda Conservation published in

1989, but this is not the main theme. His recommendations to sustain and perhaps increase panda populations, the WWF-Chinese government negotiations and the eventual use of the considerable financial investment and equipment, are interesting insights into Panda Politics, and by extension some other wildlife projects. Very often the state-of-the art equipment was under used or not used at all. The greatest threat to pandas is People: Pandas require large tracts of different species of bamboo in order to flourish and breed. Interference in the ecosystem by deforestation and new settlements in the panda ranges is one problem; add to that capture by hunters (for pelts, meat, and body parts, for which there is a large market) and by researchers; and the periodic death of the bamboo. These factors have had appalling effects on populations - which were none too large to begin with. Loans of pandas to western zoos for display, and which fill zoo coffers, bring in needed foreign currency, but deprive wild populations of breeding-age animals. The policy of capturing pandas, ostensibly for breeding under controlled conditions, has been mostly unsuccessful.

Schaller's forecast for the future is sanguine. Wild panda populations are barely surviving and the scientists' recommendations have not been acted on. One such recommendation is to link the separated reserves in Sichuan into one large one by creating corridors between the panda ranges. This could be the last hope for that area, but there is a lack of cooperation between the various agencies which are responsible for the ranges: the Chinese Ministry of Forest & Development, The Environmental Protection Office, and The China Association of Zoological Gardens. These agencies, and others have their own bureaucracy and agenda. China is not unique.

This is a very interesting inside look at the difficulties of co-operative conservation between two different cultures. The lessons learned, though, can be applied universally. Highly recommended if you really care about all endangered species.

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The Birds of Great Slave Lake, Northwest Territories, Canada

By Jacques Sirois. 1994. Ecology North, Yellowknife, N.W.T. 36 pp. \$3.00

The Birds of the Northwest Territories

By Jacques Sirois and Doug McRae. 1994. Canadian Wildlife Service, Yellowknife, N.W.T. 28 pp. Free.

These two pamphlets share several features – a common author, a physical description and map detailing the areas they cover, a description of sites in which to birdwatch, precautions to take while birding, a short but adequate introduction of the literature pertaining to their respective regions, a Canadian Wildlife Service address for further information or to report sightings, an indication of abundance and status of species in their areas of coverage, and a checklist of confirmed and unconfirmed bird species.

Because it covers Great Slave Lake and a 50-km area around the lake the first booklet contains more details than the general work on the Northwest Territories. The Great Slave Lake book gives brief information on access to birdwatching areas and suggestions for timing of visits. The book lists 15 "Highlights" and 20 "Curiosities". It covers abundance and status of selected species. The 7-page checklist gives only common names for 237 confirmed and 10 unconfirmed species. Its shirt-pocket size allows it to be carried easily. A quote from John Richardson entitled "Thoughts From The Past" does not add anything and probably should have been deleted to allow a more complete discussion of status and abundance of species.

The booklet covering the entire Northwest Territories is physically larger (14 × 21.5 cm) but has fewer details on the logistics a birdwatcher faces. Surprisingly there are only 77 more confirmed species for the whole Northwest Territories (i.e., 314) than for the Great Slave Lake area. There are 16 unconfirmed species for the Northwest Territories. Common and Latin names are given in a 10-page species list along with explicit indication of the status of each species in four broad geographical regions: Western Cordillera (west of the Mackenzie and Liard Rivers), Mainland (area east of these rivers), Arctic Island (marine water and islands north of 60°N), and Bay Islands (islands and water of Hudson Bay south of 60°N and James Bay). These areas are perhaps too broad, for example the Mainland region contains boreal, subarctic, low arctic, and mid-arctic zones, although criteria for distinction of these zones is not discussed. Included in the reference section is a listing of five general birdwatching guides. A criticism is that several settlements are not shown on the map. People unfamiliar with the north may not realize there are settlements making access to these areas somewhat easier.

While both of these card-covered, stapled references will need to be used in conjunction with a field guide, they make an excellent starting point for beginning birders within and for birders from outside the localities they cover. The book on Great Slave Lake is available from Ecology North - a non-profit organization dedicated to public education and environmental conservation. The work

covering the Northwest Territories is free from the Government of the Northwest Territories Department of Economic Development and Tourism.

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Bird Song

By C. K. Catchpole and P. J. B. Slater. 1995. Cambridge University Press, New York. viii + 248 pp., illus. U.S. \$32.00.

Bird fans and professionals alike will be grateful for this highly readable synthesis of the vast literature of this active topic of investigation. Both authors are well known for their own contributions, and have collaborated successfully by attending to Tinbergen's four famous programmatic aspects of behaviour, namely causation, development, function, and evolution.

The book opens with a general consideration of signals and communication, sound as a modality, the terminology for components of bird song, and techniques of recording and analysis, with appropriate emphasis on the usefulness of interactive digital sound emitters and the problem of pseudoreplication in experimental design. More emphasis on the validity and reliability of recognizing components would have been desirable because so much of subsequent issues such as repertoire size depends on this.

Production and reception of sound are examined in terms of anatomy and physiology, including neural changes and localization of sounds. The developments of song includes key phenomena such as templates, memory, social factors, accuracy, mimicry, and phylogenetic distribution. Especially valuable here are the presentations of recordings, and the discussion on the functionality of learning.

There are chapters on the transmission of song (including attenuation and degradation, the role of habitat, and interpretation of critical features) and the timing of song in terms of breeding, hormones, the dawn chorus (whose possible causes are carefully considered), and competitive aspects. Under diverse types of social recognition ranging from species to individuals in territorial defence, the diversity of experimental techniques employed are well described. The role of song in sexual selection is outlined in depth, particularly stimulation for extra-pair copulations and aspects of repertoire size. A superb chapter on themes and variations (which also provides the subtitle for the book) fully investigates such major subjects as the organization of repertoire, duets and choruses, and the evolution and function of versatility. Finally, variation in space and time is considered in such terms as dialects and cultural change. The resulting book is an excellent exposition written in a clear and flowing style.

The layout is generous and well illustrated, with references and index. Particularly valuable are the descriptions of case studies and the presentation of alternative interpretations for controversial issues. The wide audience for whom this book is intended will welcome it.

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BOTANY

A History of the Orchid

By Merle A. Reinikka. 1995. Timber Press, Portland, Oregon. 324 pp., illus. U.S. \$29.95.

Orchids, an exotic topic for a Canadian field naturalist. Journeys into dense greenery, life everywhere, all around, breathing. When I agreed to review *A History of the Orchid* by Merle A. Reinikka, I hoped to read at least a few of those exotic stories of adventures into the unknown of early collectors and natu-

ralists. On reading the book, it is immediately evident that there is an astounding amount of historical information of interest to someone interested in the history of botany or taxonomy or orchid culture. I noted that the book itself is a revised and fully updated version of a 1972 edition by the same name, an established and respected book. There are many great stories too. A potential buyer should know that

this author is not a story-teller like Peter Matthiessen. Mr. Reinikka tells his stories fairly bare boned and so you supply much of the flesh.

I will give a few tidbits I gained from this informative book. The name Orchid comes from the Greeks referring to the testiculated bulbs or tubers of their local plants. The interest was herbal and even up to the 17th century orchids were prescribed (following Dioscorides's Doctrine of Signatures) as remedies for male sexual problems. Field naturalists observing the plants noticed the flowers had no seeds but a dust and concluded that orchids were products of animal semen. This theory was developed to fair complexity backed by "observant field naturalists".

The orchid as a flower made its impact in the West when in 1818 a *Cattleya labiata* arrived accidentally in England. It was either the packing material or used to tie some other tropical specimens. A curious naturalist named William Cattley chose to try to grow it for some reason. He was successful and what a success.

The original location was discovered by a Dr. Gardener in the then semi-remoteness near Rio De Janerio where the plant thrived. But by the time word got back to England, this area was totally destroyed to make room for coffee plantations. An intense and well-funded search was undertaken but this plant was not found for another 50 years. Meanwhile other species were found and the orchid craze was in full gear.

Plants were bought and sold for small fortunes. Rain forests that these plants depended on were often razed to obtain them. One group of collectors in an effort to obtain the showy and desirable *Odontoglossum crispum*, cut down 4 000 trees to collect 10 000 plants. Ruthless is the word that comes to mind. Some parts of Central and South America remain to this day without natural orchids. I did also note that the collectors, who as a group inflicted such damage, themselves encountered great dangers and death in this new land so different from England.

The last two-thirds of the book is dedicated to biological notes of 51 people who played prominent parts in the history of the orchid. To give you an idea of this I have given a few points that I learnt from reading one of these biographies.

Charles Darwin states in a letter in 1861, two years after his ground breaking *On the Origin of Species by Means of Natural Selection*, "I never was more interested in any subject in my life than this of Orchids," [In letter to Sir Joseph Hooker quoted on page 181]. He spent considerable time and energy helped by sons and friends doing field studies of orchid pollination. He was very impressed by the complex symbiotic relationships that existed between various orchid and certain insects. He made his famous prediction of the moth with a foot long proboscis (*Xanthopan morgani praedicta*) upon viewing the unusually long nectar tube of the Madagascar orchid species *Angraecum sesquipedale*. This prediction came out of a background of intense field study and observation, not idle speculation. By the way, this and many other "historic" orchids do make wonderful house plants. Darwin published a book on the relationship of insects and orchids in 1862 which he felt was the needed evidence to uphold his theories, but which also laid the foundation for any further work on that branch of orchidology.

As you may have concluded by now, *A History of the Orchid* is packed full of facts, details, and information. It lacks an overall coherence because it covers many diverse aspects like taxonomy, cultivation, hybridization, collecting, and scientific application. It does do exactly what the author intended, namely, give a concise history of all aspects of orchids. It doesn't speculate, deviate, or stray much. It is thick reading, if read cover to cover. On the other hand it is clear and thorough and would serve as an excellent reference book on orchid history for a library or for someone especially interested in orchids.

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The Ontario Naturalized Garden

By Lorraine Johnson. 1995. Whitecap Books, North Vancouver. 188 pp., \$18.95.

For the average gardener or would-be gardener, with limited knowledge of natural history or ecology, really good information on naturalizing has been far too scattered in arcane publications to be of much use. In addition, the rapid increase in publications on aspects of naturalizing only adds to the confusion — which authority to consult? Many of the current books cover a wide geographical area,

have limited subject matter, or have little application to Ontario. This is what makes this book so worthwhile and timely. At long last Ontario gardeners, and naturalists who want to naturalize, have a book that can advise them on what they can do in their yards, why they should do it, and what plants they should use.

The book is divided into three parts and has an extensive bibliography. Part One gives the basic arguments for naturalizing, introducing such important concepts as the ecological value of indigenous

species, an introduction to Ontario's ecological zones, some philosophical underpinnings as to the community benefits of naturalizing, and an overview of how settlement has contributed to the increase of aliens at the expense of native species.

Part Two is the practical "how-to" of naturalizing, covering the types of native plant communities and describing their habitats, plus design of a native plant garden, plant propagation, acquisition of native plants, and species lists for various habitats.

Part Three discusses such important issues as weeds, lawns, and wildlife, and where they fit into the naturalization process. In summary, the book touches all the bases while concentrating on the most practical ways to encourage people to naturalize.

It is hard to underestimate the importance of the naturalization movement and how a timely, personal and popular book with good ideas could make it grow. As Johnson recognizes in her book, native plant gardening will grow because its key ideas make a lot of common sense as well as environmental sense. Who can argue with ideas that encourage species diversity and reduced use of fertilizers, toxic sprays, and water? It is not surprising to learn that Lorraine Johnson is a Director of the Canadian Wildflower Society. The book encapsulates much of the Society's philosophy and native plant knowledge as set down in its magazine, *Wildflower*. No wonder that its editor, James Hodgins, refers to this book as "a pioneer work that will be a touchstone for years to come". I heartily concur.

As a naturalist and an environmentalist, I have long marvelled at the quality and intellectual rigour of *Wildflower*. I believe the widespread adoption of its philosophy and ideas have more potential to change the average person's attitudes and relationship with nature than any other movement. It's based

on the idea that anyone with a little knowledge and interest in the natural world can, through working with native plants, begin to understand their relationship with nature. This practical hands-on approach is intended to bring about a personal ecological awakening and attitudinal shift from dominance of nature to partnership with nature.

As we have become increasingly urban, and our contact with wild areas increasingly remote, we have created an environment where our planning, engineering and gardening practices are mostly hostile to the natural order. At long last we have a tool that can help to redress the balance.

In addition to practical advice, this book includes an extensive section entitled Further Reading and Resources. Here are listed important books and resource materials on ecology and the environment, gardening, native plants and natural history, magazines, native plant sources, and organizations.

In its purest form, naturalization has the potential to introduce people to plant communities, and through attempts at restoration, it offers a way to start learning about how they function. Wildlife gardening, planting not just to create plant communities, but to attract insects, amphibians, reptiles, mammals, and birds, is a logical extension. The whole movement, through the diversity of ways it draws in people's interests, is the key to widespread adoption. As someone working in the naturalizing movement, it's wonderful to have a thoughtful and practical book that I can heartily recommend to expert and would-be naturalizers.

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ENVIRONMENT

Canada's Biodiversity: The Variety of Life, its Status, Economic Benefits, Conservation Costs, and Unmet Needs

By Ted Mosquin, Peter G. Whiting, and Don E. McAllister.
1995. Canadian Museum of Nature, Ottawa. 293 pp., illus. \$45.00.

A conservation axiom has developed that to maintain biodiversity is to ensure a healthy environment. Any activities that do otherwise will lead to a loss of ecological integrity. As a buzzword of the 1990s, biodiversity is a double-edged sword; the public and decision-makers understand and support the principle of diversity, but they do not comprehend the complexity of the issue, the extent of ignorance on the part of the proponents, or the enormity of the task of managing what is in effect, the entire planet

from alleles to the Arctic. A new book *Canadian Biodiversity: The Variety of Life, its Status, Economic Benefits, Conservation Costs, and Unmet Needs* is an important step in rectifying the ignorance and complexity of biodiversity in Canada and a timely arrival as governments and managers, committed to the Rio Convention on Biological Diversity, begin to address the formidable task of maintaining biodiversity.

There are many people, including scientists and managers, who believe species diversity is biodiversity. In fact, there are three levels of biodiversity; genetic, species, and community/ecosystem. All lev-

els are discussed throughout the book, often, quite correctly as interrelated parts of the same system. But, more important than the addition of genes and communities, is the recognition of the processes that create diversity at these levels. To their credit, the authors of Canada's Biodiversity use a separate chapter to underline the importance of such ecological functions as soil creation, nutrient cycling, dispersal, stability, and plant succession to understanding and maintaining biodiversity.

The remaining chapters cover a wide range of topics on the status, economics, and management of biodiversity in Canada. The issue of exactly what constitutes biodiversity is well established, and I found the inclusion of domestic species with native species a good means of incorporating agricultural interests with those of biodiversity. However, concerns over the conservation of natural biodiversity outweigh concerns over agricultural and domestic species and I was surprised that a stronger priority to the role of native diversity was not evident throughout.

Much of the value of this book relates to the wealth of data in the 100 pages of appendices. Fourteen appendices present data on the number, dis-

tribution, and rarity of species, the status of protected areas, and the economic value and costs of biodiversity. Thus, in one reference, a reader can determine that Canada has two recognized species of *Thysanura* (silverfish), 27 of 29 national marine regions are unrepresented by protected areas, and that wild fungi are worth up to 30 million dollars annually. Many topics are covered in detail but several jurisdictions lack the data on many topics and future editions will be required to complete some appendices, particularly the measures and costs of conserving biodiversity.

The only real limitation of the book is that the scope of the coverage, as evidenced in the title, does not permit the level of detail necessary to make this book a stand-alone reference on any particular topic. However, as an overview of biodiversity in general, and for Canada in particular, the book should be considered integral to every Canadian interested in nature conservation.

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The Greening of Ethics

By Richard Sylvan and David Bennett. 1995. The White Horse Press, Cambridge, U.K. and the University of Arizona Press, Tucson. 269 pp. Cloth U.S. \$45; paper U.S. \$22.95.

Sylvan and Bennett teach philosophy in Australian universities, and are both very interested in environmental philosophy in particular. *The Greening of Ethics* is based on the results of a UNESCO project to investigate environmental ethics in Australia. It was written in order to establish what environmental ethics is and what it is not, in which directions environmental ethics are going, and to recommend methods and actions for promoting them. The resulting discussion swings wildly from basic environmental good sense (Reduce, Reuse, Recycle) to some very convoluted and foggy propositions. New words have been coined to describe the proposals, and commonplace words are often used in new and inappropriate ways. Some of the theories are so difficult to follow one wonders whether the authors themselves have a clear concept of them. When an inappropriate word is used, it is often followed by the dictionary definition, but sure-

ly giving a dictionary definition of a word used out of context does not make it legitimate!

Is it possible that the environmental movement in Australia has lagged behind North America? If this is the case it may explain why some of the early, elementary environmental principles of the 1970s are given prominence in the book.

The text also focuses on the "Deep Green" and "Deep Ecology" theories, and on the application of philosophical systems to them. There are mathematical formulae and figures such as "Annular picture of moral rings in object space (and the position of Humans)" (page 141). This is an indication that this is far from an easy book to read, but it may appeal to intellectuals, trained in philosophy, who are on the leading edge of environmental ethics and who, by advocating environmental theories and philosophy, play their part in changing attitudes towards the environment.

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Wildlife and Recreationists: Coexistence Through Management and Research

Edited by Richard L. Knight, and Kevin J. Gutzwiller.
1995. Island Press, Washington, D.C. 372 pp., illus.
Cloth U.S. \$49.95; paper U.S. \$27.50.

The objective of this book was to provide "practical value in helping minimize or ameliorate the negative impacts of recreation on wildlife". I believe the authors have achieved this objective and more.

The book consists of 21 chapters which are combined into four major topics broadly defined as General Issues, Specific Issues, Case Studies, and Ethics and Answers. General Issues provide conceptual overviews of broad topics relevant to the theme of this book including historical and anticipated trends of outdoor recreation, human dimensions of wildlife management, and the origin of wildlife responses to recreationists. Specific Issues provides reviews of more defined aspects of recreationist-wildlife interactions such as indirect effects of recreationists on wildlife and responses of wildlife to noise. Case Studies brings the reader a series of well-researched papers on highly-publicized issues including the effects of hunting on waterfowl, beach recreation and nesting birds, and waterborne recreation and the Florida manatee. Most of the chapters include several tables and figures, many of which draw upon the authors own

research or similar scientific studies which augment the text well. Although written by a group of well-known researchers, this book is written in a manner easily understood by scientists and laypeople alike.

Beyond the fact that the authors bring together a myriad of fundamentally similar topics relative to effects of human activity on wildlife, I believe the most beneficial aspect of this book is its practical approach. Rather than simply state there is a problem and something should be done about it, many of the chapters provide realistic solutions to alleviate the problem and suggest areas of future work to provide a greater understanding of the problem to improve management efforts.

Wildlife and Recreationists provides considerable insight and awareness of the problems and needs for management of the complex and imperative issue of human-wildlife coexistence. It will appeal to a broad cross-section of society and is recommended to anyone with an interest in our relationship with, and stewardship for, the environment.

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Conservation Biology in Theory and Practice

By G. Caughley and A. Gunn. 1996. Blackwell Science, Cambridge. 459 pp., illus. U.S. \$44.95.

In a world of declining biological resources an understanding of conservation would seem to be knowledge of interest to individuals involved in slowing or halting the decline. The purpose of *Conservation Biology in Theory and Practice* is to provide this knowledge and/or means of obtaining it for this target group. The authors' secondary aim is to demonstrate the need to understand the ecology of species in trouble and the necessity of applying scientific method to determine why species are driven into decline and how this can be reversed.

The transfer of information is accomplished with a great deal of reliance on case studies of animal species. Caughley and Gunn provide the reader with examples of why it is best to look at the ecology of the organism(s) in question. They also introduce the human element of the problem. The human element often being peoples' economic aspirations which can be seen as part of the problem but also part of the answer.

The information is supplied in a concise and highly readable manner. The use of case studies helps in bringing a sense of reality to the problem. They help demonstrate past failures and successes. They also

point out the great difficulty in determining sources of the problem and possible solutions. The major problem is often lack of data.

The authors emphasize over and over the need to follow standard scientific methodologies. They repeatedly demonstrate the lack of actual facts when dealing with organisms threatened with extinction. One quote: "Scientific ignorance should be recognized for what it is and not treated as anything else forces one to confront this lack of information" emphasizes what the authors see as one major problem.

The reader is provided with chapter summaries, references, and index to aid in using the book for later reference. I did note a few of the references in the text failed to correspond with their listing at the back of the book. On the whole though one is provided with a good overview of the subject of conservation with a clear and concise introduction to the methodologies required. The book could be used as text at the undergraduate level, or a handy reference for those interested in staving off extinction.

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Macroecology

By James H. Brown. 1995. University of Chicago Press, Chicago. xiii + 269 pp., illus. Cloth U.S. \$42.50; paper U.S. \$15.75.

A large proportion of today's ecological studies provides information dealing with a specific taxon, microsite, or defined population. *Macroecology* discusses approaches and techniques to study the ecology of the biosphere or the "bigger picture". James Brown writes this monograph, in his own words, as "a blatant advocacy" looking at the positive features of macroecological research. The macroecology approach provides a possible opportunity to see the big picture despite the loss of detail found with the more standard reductive and inductive procedures.

The author arranges the material for his monograph in 13 chapters. Each chapter ends with concluding remarks. Brown describes macroecology as "way of studying relationships between organisms and their environment that involves characterizing and explaining statistical patterns of abundance, dis-

tribution, and diversity" by drawing on a variety of disciplines such as biogeography, paleobiology, systematics, and conservation biology. He does not attempt to provide a complete literature review but does provide a healthy well-organized overview of the literature. Nor does he make an attempt to provide a final statement on the subject but hopes the book will contribute to its own obsolescence.

James Brown has authored a book which reveals some of his excitement for the subject. A book with its ultimate value, he wishes, to be determined by the impact upon the reader. The impact on this particular reader has been positive. As a result *Macroecology* will be placed on the shelf for easy access and strongly recommended to those with an interest in the larger ecological picture.

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Fundamentals of Conservation Biology

By M. L. Hunter. 1995. Blackwell Science, Cambridge, Massachusetts. xiv + 482 pp., illus. U.S. \$42.95.

In recent years the field of conservation biology has captured a large amount of publicity. There are several new courses offered by universities to cover the subject area but, as with any new subject area, text books were missing. When Malcom Hunter started writing this text, there were very few possible texts. Recently this has changed with a number of books being published to fill the gap *Fundamentals of Conservation Biology* is intended to be a text for an introductory course in conservation biology and an introduction for readers with a general interest in the field.

The book has 17 chapters divided into four main sections: Biodiversity and its importance, Threats to Biodiversity, Maintaining Biodiversity, and The Human Factors. Each chapter is provided with subsections, listed in the table of contents for easy reference, ending with a summary. The chapters also contains at least one case study to bring the material some sense of reality. For the intrigued, further readings and discussion questions are provided in each chapter. The discussion questions should provide

some lively discussion and self exploration. All 17 chapters are arranged to provide a coherent progression through the material. For ease of reference to specific information within the text, an index and list of references are provided at the end of the text.

Dr. Hunter has provided an interesting introduction to conservation biology. He has attempted to suggest a change from anthropocentric to biocentric perspective. The intrinsic value of organisms is discussed. He raised a number of interesting questions including "if beaver and reef building corals can shape landscapes in positive ways, why can't people? Can people improve natural ecosystems?" His references tended to be mostly from the field of conservation even for areas where other sources are available in greater quantity. His discussion of certain topics tended to be one sided occasionally. But overall Dr. Hunter has provided a good general introduction and a good read for those with a general interest in the field.

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Drinking Water: Refreshing Answers to All Your Questions

By James M. Symons. 1995. Texas A&M University Press, College Station, Texas. Canadian distributor U.B.C. Press, Vancouver. 160 pp., illus. Cloth \$36.95; paper \$16.95.

Although this book is one of a "Natural Environment Series", it is aimed at householders, not at naturalists. It is written in question-and-answer format, with 128 questions. Here is No. 120: "Does drinking water contain calories, fat, sugar, caffeine,

or cholesterol?" The answer is "No", accompanied by a sketch of a glass of water overprinted with a list of the above-named substances, each followed by "0 mg", and a list of the ingredients, to wit, hydrogen and oxygen. To be fair, some of the questions are mildly interesting.

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Eastern Deciduous Forest: Ecology and Wildlife Conservation

By Richard H. Yahner. 1995. University of Minnesota Press, Minneapolis. xvii + 220 pp., illus. U.S. \$18.95.

It is difficult to know how to classify this book. Heavily burdened with references and with a dry writing style this thin volume is clearly not aimed at a general audience. And yet, with its superficial treatment of the topics it can only make for a very junior level textbook.

Yahner is ambitious in his coverage. In 10 chapters he covers everything from the history of the eastern deciduous forest since the last ice age to the current ecological concerns over forest fragmentation, and the future of the forest. In between, he tackles succession, plant-animal interactions, biodiversity, and atmospheric threats such as acid rain. In trying to be all encompassing too often chapter sections resemble little more than lists of topics. More detailed examination of some of the studies

mentioned might have provided greater insight into the complexity of the issues. There are also a few careless mistakes in the text: typos and in one instance, the misuse of the word fauna when flora was intended.

The book also suffers from an obsessiveness with references. For example, the self-evident statement "Forests are an economic and a recreational treasure for all Americans" is supported by three references, occupying a full line of text!

Despite these problems, the book does provide a broad survey of forest ecology and perhaps would make a useful text for an introductory course in ecology.

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MISCELLANEOUS

River out of Eden

By Richard Dawkins. 1995. BasicBooks, New York. 172 + xiii pp. U.S. \$28.00.

Richard Dawkins is (in)famous for his perceptive and witty books on Darwinism, and so a reader approaches this one with anticipation. Those who have not previously read him will be delighted, but those already familiar with his previous writings will be disappointed. The title refers to the river of DNA coursing over the temporal landscape of biology. Dawkins expands on the central role of natural selection in this river, the nature of speciation, and the view of genetic material as information underlying complexity, embryology, and adaptation. He then takes a historical view in order to address issues of inbreeding, sexual reproduction, phylogenies, molec-

ular clocks, and an African Eve. Dawkins expounds his thorough-going adaptationism well by analyzing natural design, its gradual appearance with plenty of time and variation, and pertinent examples, especially from animal behaviour. Confounding those who search for purpose, he demonstrates the blind effects of natural selection maximizing genetic survival through instances of sex ratio, competition, and the evolution of senescence, but is adamant in drawing no moral. Finally, Dawkins focusses on "the replication bomb", the consequences of molecular replication exploding with information, like the memes of a chain letter, with life crossing a series of thresholds from genotypes through phenotypes and consciousness to space travel.

The treatment of these topics is generally light, zesty, and certainly less detailed than in his previous books. As ever he is messianic in his Darwinism, strident (against the arguments of religionists, and, within science, of supporters of punctuated equilibria), and provocative ("there is more poetry in Mitochondrial Eve than in her mythological namesake"). Some claims jar, such as the suggestion that Ronald Fisher could be regarded as Darwin's greatest twentieth-century successor, and reference to "purebreds" by one so versed in modern genetics. And the announcement that 1953, the year of the double helix, "will come to be seen ... as the end of mystical and obscurantist views of life" may apply to some people but certainly not to any society at large.

Overall this volume is neither a general introduction to Darwinism nor an advanced work exploring some central theme such as the evolving intellectual framework of Darwinism (cf. Depew and Weber's *Darwinism Evolving* reviewed in *The Canadian Field-Naturalist* 109: 515) or evolution-

ary ethics (cf. Ruse's *Evolutionary Naturalism* reviewed in *The Canadian Field-Naturalist* 110(3): 568). An author who has worked hard to conclude that "Nature is neither kind nor unkind" might have been expected to say at least something about ethics.

Subtitled *A Darwinian View of Life*, this is a volume in a Science Masters Series of "short, easy-to-read, attractive books" conveying cutting-edge ideas to a broad audience. It is on a par with the one other volume of this series that I have seen, but is shallow compared with Dawkins' excellent other books. Hence the conclusion to date, although the list of future contributors is stellar, must be that these volumes are light introductions, fine as such, but pale reflections of substantial works.

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Diary of William W. Judd: Sifton Botanical Bog (Byron Bog) London, Ontario, 1981-1993

By W. W. Judd. 1995. Phelps Publishing, London. iii + 25 pp. \$5.00.

This booklet is the author's third diary on the Byron Bog of London, Ontario. The previous two covered the years 1961-1966 and 1967-1980, although I have not seen them. Anyone expecting rich personal observations by an eminent scientist on the changing natural landscape of the Byron Bog will be sorely disappointed. Judd's entries are terse, sometimes almost in point form: date (occasionally even this is missing), weather, time of visit, plants in bloom, and animals seen or heard. Each year's

entries average only a page in length, with the remaining 12 of 25 pages occupied by appendices. The appendices thoroughly cross-reference the diary by people referred to in the diary and plants and animals mentioned in the text. Judd evidently knows a great deal about the bog; it is a shame he has not shared it more fully with the rest of us.

DAVID SEBURN

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NEW TITLES

Zoology

***American marten, fisher, lynx, and wolverine: survey methods for their detection.** 1995. Edited by W. J. Zielinski and T. E. Kucera. General Technical Report PSW-GTR-157, Pacific Southwest Research Station, U.S. Department of Agriculture, Albany, California. 163 pp.

***American Museum of Natural History: 125 years of expedition and discovery.** 1995. By L. Rexer and R. Klein. Harry N. Adams, New York. 256 pp., illus.

***Amphibian biology, volume 1: the Integument.** 1994. Edited by H. Heatwole and G. T. Bartholomew. Surrey Beatty, Chipping Norton, Australia. 418 pp., illus. U.S. \$92.

***Amphibian biology, volume 2: social behavior.** 1995. Edited by H. Heatwole and B. Sullivan. Surrey Beatty, Chipping Norton, Australia. pp.419-710, illus.

***The amphibians and reptiles of the Yucatan Peninsula.** 1996. By J. C. Lee. Cornell University Press, Ithaca. 500 pp., illus. U.S. \$175.

***The birds of British Columbia: Volume 3: passerines (flycatchers through vireos).** 1997. By R. W. Campbell, N. K. Dawe, I. McTaggart-Cowan, J. M. Cooper, G. W. Kaiser, M.C. E. McNall, and G.E.J. Smith. University of British Columbia Press, Vancouver. c635pp., illus. \$95.

†**The breeding birds of Québec: atlas of the breeding birds of southern Québec. Les oiseaux riches du**

- Québec.** 1996. Edited by J. Gauthier and Y. Aubry. Association québécoise des groupes d'ornithologues, Province of Québec Society for the Protection of Birds and Canadian Wildlife Service, Montreal. Éditions Multimondes, Saint-Foy. (English and French, review copy is English) 1302 pp., illus. \$149.95.
- Coming of age with elephants, a memoir.** 1996. By J. Poole. Hyperion, N.Y. xi+288 pp., illus. U.S. \$24.95.
- ***Cranes: their biology, husbandry, and conservation.** 1996. Edited by D. H. Ellis. G. F. Gee, and C. M. Mirande. Hancock House, Surrey, B. C. xii+307 pp., illus. \$69.95.
- †**Demography of the northern spotted owl.** 1996. Edited by E. D. Forsman, S. De Stefano, M. G. Raphael, and R. J. Gutierrez. Studies in Avian Biology No. 17. Proceedings of a Workshop, Fort Collins, Colorado, December, 1993. Cooper Ornithological Society, Camarillo, California. 122 pp., illus. U.S. \$20.
- Eagle's plume: preserving the life and habitat of America's bald eagle.** 1996. By B.E. Beans. Scribner, New York. 318 pp., illus. U.S. \$25.
- The earth dwellers: adventures in the land of ants.** 1996. By E. Hoyt. Simon and Schuster, New York. 319 pp., illus. U.S. \$24.
- The ecology of migrant birds: a neotropical perspective.** 1996. By J. H. Rappel. Smithsonian Institution. P., Washington. xvi + 269 pp., illus. U.S. \$35.
- ***Encyclopaedia of Canadian Fishes.** 1996. By B. Coad. Canadian Museum of Nature, Ottawa. 928 pp., illus. \$100.
- ***Field guide to the birds of the Middle East.** 1996. By R. F. Porter, S. Christensen, and P. Schiermacker-Hansen. T & A.D. Poyser, London, England. Xv + 460 pp., illus. + plates. £29.95.
- ***The historical atlas of breeding birds in Britain and Ireland 1875-1900.** 1996. Compiled by S. Holloway. T & A Poyser, London, England. 476 pp., illus. £25.
- Hyperiid amphipods (Amphipoda, Hyperiida) of the world ocean.** 1996. By M. E. Vinogradov, A. F. Volkov, and T. N. Semenova. Science Publishers, Lebanon, Michigan. 650 pp. U.S. \$178.
- Larvae of marine bivalves and echinoderms.** 1997. By V. E. Kasyanov, G. A. Kryuchova, V. A. Kulikova, and L. A. Medvedva. Science Publishers, Lebanon, New Hampshire c350pp.
- †**Life of the flycatcher.** 1997. By A. F. Skutch. University Oklahoma Press, Norman. 192., illus. U.S. \$40.
- Mammals of the Soviet Union, volume 1, part 3: pin-nipeds and toothed whales (Pinnipedia and Odontoceli).** 1996. By V. G. Heptner. Science Publishers, Lebanon, New Hampshire. c1000pp. U.S. \$225.
- Mammals of the Soviet Union, volume 2, part 1a: sea cows, wolves, and bears.** 1997. Edited by V. G. Heptner. Science Publishers, Lebanon, New Hampshire. c750pp. U.S. \$195.
- †**Metapopulations and wildlife conservation.** 1996. Edited by D. R. McCullough. Island Press, Washington. x + 429 pp., illus. Cloth U.S. \$55; paper U.S. \$28.
- ***Monitoring bird populations by point counts.** 1995. Edited by R. C. John, J. R. Sauer, and S. Droege. General Technical Report PSW-GTR-149, Pacific Southwest Research Station, U.S. Department of Agriculture, Albany, California. 187 pp.
- ***Pleistocene amphibians and reptiles in North America.** 1995. By J. A. Holman. Oxford University Press, New York. 243 pp. U.S. \$65.
- ***Snakes in question: the Smithsonian answer book.** 1996. By C. H. Ernst and G. R. Zug. Smithsonian Institution Press, Washington. xii + 203 pp., illus. + plates. Cloth U.S. \$49; paper U.S. \$24.95.
- The venomous and poisonous marine invertebrates of the Indian Ocean.** 1996. By F. E. Russell and R. Nagabhushanam. Science Publishers, Lebanon, New Hampshire c270 pp. U.S. \$89.
- ***The wood duck and the mandarin: the northern wood ducks.** 1996. By L. L. Shurtleff and C. Savage. University of California Press, Berkeley. 232 pp., illus. U.S. \$34.95.

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- †**The alpine flora of the Rocky Mountains, Volume 1: the middle Rockies.** 1997. By R. W. Scott. University Utah Press, Salt Lake City. 768 pp., illus. U.S. \$110.
- †**Balancing act: environmental issues in forestry.** 1996. By H. Kimmins. 2nd edition. University British Columbia Press, Vancouver. 305 pp., illus. \$29.95
- Conifers: the illustrated encyclopaedia.** 1996. By D. M. van Gelderen and J. R. P. van Hoey Smith. 2 volumes. Timber Press, Portland, Oregon. 706 pp., illus. U.S. \$125.
- Contemporary plant systematics.** 1997. By R. R. Kowal, K. J. Sytsma, M. Clayton, M. J. Ward, and D. Woodland. Andrews University Press, Berrien Springs, Michigan. 680 pp., illus. + CDRom. U.S. \$59.95.
- Fungi on rhododendron: a world reference.** 1996. By D. F. Farr, H. B. Esteban, and M. E. Palm. Parkway Publishers, Boone, North Carolina. 192 pp. U. S. \$45.
- Meeting the tree of life: a teacher's path.** 1997. By J. Tallmadge. University Utah Press, Salt Lake City. 220 pp. Cloth U.S. \$44.95; paper U.S. \$18.95.
- ***Michigan flora, part III: dicots (Pyrolaceae-Compositae).** 1996. By E. G. Voss. Cranbrook Institute of Science, Broomfield Hills, Michigan. xix + 622 pp., illus. U.S. \$15.
- Mycology in sustainable development: expanding concepts and vanishing borders.** 1997. Edited by I. H. Chapela and M. E. Palm. Proceedings of an international Workshop, San Diego, 9 August 1995. Parkway Publishers, Boone, North Carolina. c150 pp., U.S. \$40.

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- †**The abstract wild.** 1996. By J. Turner. University Arizona Press, Tucson. xvii + 136 pp. Cloth U. S. \$32.50; paper U.S. \$15.95.
- ***British Columbia: a natural history.** 1996. By R. and S. Cannings. Greystone Books, Douglas and McIntyre, Vancouver. 310 pp., illus. \$45.

- *Conservation of Great Plains ecosystem: current science, future options.** 1995. Edited by S. R. Johnson and A. Bouzaher. Kluwer Academic Publishers, Hingham, Massachusetts. xvii + 434 pp., illus. U.S. \$192.
- †**Deeper ecology: essays on ecological spirituality.** 1996. By D. A. Doyle. Wild Side Publishing, Eureka, California. 47 pp., U.S. \$6.95 + U.S. \$3 shipping + U.S. \$10 foreign.
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- †**Ecology of a polar oasis: Alexandra Fiord, Ellesmere Island, Canada.** 1996. Edited by J. Svoboda and B. Freedman. Captus Press, North York, Ontario. 286 pp., illus. \$38.50.
- Environmental geology of urban areas.** 1997. Edited by N. Eyles. Geological Association of Canada, Memorial University, St. John's Newfoundland. 608 pp. \$95; U.S. \$81.
- Environmental harm: civil actions and Compensation.** 1996. By M. D. Faiela, H. B. Kolm, R. Kligman, and J. Swaigen. Butterworths, Markham. 688 pp. \$176.
- Environmental law: a guide to concepts.** 1996. By B. Pardy. Butterworths, Markham. \$53.
- †**Evolution and environment in tropical America.** 1996. Edited by J.B.C. Jackson, A. F. Budd, and A. G. Coates. University Chicago Press, Chicago. ix + 425 pp., illus. Cloth U.S. \$27.50.
- The forgiving air: understanding environmental change.** 1996. By R. C. J. Somerville. University of California Press, Berkeley. xiv + 195 pp., illus. U.S. \$21.95.
- *Invasions of the land.** 1995. By M. S. Gordon and E. C. Olson. Columbia University Press, N. Y. xv + 312 pp., illus.
- Islands in space and time.** 1996. By D. Campbell. Houghton Mifflin, New York. pp., illus. U.S. \$35.
- Krakatau: the destruction and reassembly of an island ecosystem.** 1996. By I. Thornton. Harvard University Press, Cambridge, Massachusetts. xi + 346 pp., illus. U.S. \$39.95.
- †**Measuring and monitoring biological diversity: standard methods for mammals.** 1996. Edited by D. E. Wilson, F. R. Cole, J. D. Nichols, R. Rudran, and M. S. Foster. Smithsonian I. P., Washington. xxvii + 409 pp., illus. Cloth U.S. \$49; paper U.S. \$22.50.
- †**Misreading the Africa landscape: society and ecology in the forest-savanna mosaic.** 1996. B. J. Fairhead and M. Leach. Cambridge University Press, New York. xvii + 354., illus. Cloth U.S. \$55; paper \$19.95.
- †**The natural classroom: a directory of field courses, programs, and expeditions in the natural sciences.** 1996. By J. R. Edelman. North American Press, Golden, Colorado. 279 pp. U.S. \$32.50.
- *The natural history of pollination.** 1996. By M. Proctor, P. Yeo, and A. Lack. Harper Collins, London. 479 pp., illus. £16.99.
- *Nature guide to Ontario.** 1997. Edited by W. Wake. University Toronto Press., Toronto. c500 pp., illus. Cloth \$65; paper \$19.95.
- †**Null models in ecology.** 1996. By N. J. Gotelli and G. R. Graves. Smithsonian Institution Press, Washington. xvi + 368 pp., illus. U.S. \$30.
- Okoboji wetlands: a lesson in natural history.** 1996. By M. J. Lannoo. University Iowa Press, Iowa City. xiv + 156 pp., illus. Cloth U.S. \$29.95; paper U.S. \$14.95.
- *Restoring nature's place: a guide to naturalizing Ontario parks and greenspace.** Ontario Parks Association, Toronto and Ecological Outlook Consulting, Schomberg. v + 227 pp., illus. \$49.
- †**Riparian ecosystem recovery in arid lands: strategies and references.** 1996. By M. K. Briggs. University Arizona Press, Tucson. xv + 159 pp., illus. Cloth U.S. \$45; paper U.S. \$19.95.
- *In search of nature.** 1996. By E. O. Wilson. Island Press, Washington. x + 214 pp., illus. U.S. \$19.95.
- The shoresaver's handbook: a citizen's guide.** 1996. By T. Coomble. Lyons & Burford, New York. 138 pp., illus. U.S. \$12.95.
- Sixty years of biology: essays on evolution and development.** 1996. By J. T. Bonner. Princeton University Press, Princeton. x + 143 pp., illus. U. S. \$24.95.
- *The song of the dodo: island biogeography in an age of extinctions.** 1996. By D. Quammen. Scribner, New York. 702 pp., illus. U.S. \$32.50.
- †**Wild China.** 1996. By J. MacKinnon. MIT Press, Cambridge, Massachusetts. 208 pp., illus. U.S. \$40.
- World resources 1996-1997: a guide to the global environment.** 1996. By the World Resources Institute. Oxford University Press, New York. xiv + 365 pp., illus. U.S. \$24.95.

Miscellaneous

- †**Darwin's dream pond: drama in the Lake Victoria.** 1996. By T. Goldschmidt. Translated by S. Marx-Macdonald. MIT Press, Cambridge, Massachusetts. 274 pp., illus.
- The late Devonian Mass extinction: the Frasnian/Famennian crisis.** 1996. By G. R. McGhee, Jr. Columbia University Press, New York. xi + 303 pp., illus. U.S. \$20.
- †**Minutes of meetings 1936-1939 of the McIlwraith Ornithological Club, London, Ontario, Canada.** 1997. By W. W. Judd. Phelps Publishing, London, Ontario. (order from author, 50 Hunt Club Drive, London, Ontario N6H 3Y3). 108 pp. \$10.
- Plants, people, and culture: the science of ethnobotany.** 1996. By M. J. Balick and P. A. Cox. Freeman, New York. vii + 228 pp., illus. U.S. \$32.95.
- Summer stargazing.** 1996. By T. Dickinson. Firefly Books, New York. 64 pp., illus. U.S. \$18.95.
- The time before history: five million years of human impact.** 1996. By C. Tudge. Scribner, New York. 366 pp., illus. U.S. \$27.50.

BOOKS FOR YOUNG NATURALISTS

- Anytime weather everywhere.** 1996. By M. H. Mogh and B. G. Levine. How the Weather Works, Rockville, Maryland. 106 pp., illus. U.S. \$15.95.
- Backyard birds of summer.** 1996. By C. Lerner. Morrow Junior, New York. 48 pp., illus. U.S. \$16.
- Bizzare insects.** 1996. By M. J. Anderson. Enslow, Springfield, New Jersey. 48 pp., illus. U.S. \$15.95.
- Blood-feeding bugs and beasts.** 1996. By L. P. Kite. Millbrook Press, Brookfield, Connecticut. 48 pp., illus. U.S. \$15.90.
- Bloodsuckers.** 1996. By R. Knapp. Enslow, Springfield, New Jersey. 48 pp., illus. U.S. \$15.95.
- A brief green history of planet earth.** 1996. A. F. Alper. PPI Publishing, Dayton. 141 pp., illus. U.S. \$6.95.
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- City kids and city critters: activities for urban explorers.** 1996. By J. W. Roberts and C. Huelbig. Learning Triange Press, New York. 153 pp., illus. U.S. \$19.95.
- Dirty, rotten, dead: a worm's-eye view of death, decomposition, and life.** 1996. By J. Emory, Harcourt, Brace, San Diego. 48 pp., illus. U.S. \$15.
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- Janice vanCleave's rocks and minerals: mind-boggling experiments you can turn into science fair projects.** 1996. By J. vanCleave. Wiley, New York. 90 pp., illus. U.S. \$9.95.
- Life.** 1996. By R. Snedden. Chelsea House, New York. 48 pp., illus. U.S. \$15.95.
- Mammals.** 1996. By Time-Life Books, Alexandria, Virginia. 64 pp., illus. U.S. \$15.
- The microscope book.** 1996. By S. Levine and L. Johnstone. Sterling, New York. 80 pp., illus. U.S. \$19.95.
- Monerans and protists.** 1996. By A., V., and R. Silverstein. Twenty-first Century Books, New York. 64 pp., illus. U.S. \$16.95.
- Natural treasures fieldguide for kids.** 1996. By E. Biesiot. Roberts Rinehart, Boulder. 64pp., illus. U.S. \$12.95.
- The night sky.** 1996. By R. Kerrod. Benchmark Books, Tarrytown, New York. 64 pp., illus. U.S. \$16.95.
- Plants of the dessert; Plants of the forest; Plants under the sea; and The vegetation of rivers, lakes, and swamps.** 1996. By A. Llamas. Chelsea House, New York. each 32 pp., illus. U.S. \$14.95.
- Reptiles.** 1996. By Time-Life Books, Alexandria, Virginia. 64 pp., illus. U.S. \$15.
- Seismosaurus: the longest dinosaur and Utahraptor: the deadliest dinosaur.** 1996. By D. Lessem. Carolrhoda, Minneapolis. each 40 pp., illus. U.S. \$14.95.
- Super science fair sourcebook.** 1996. By H. M. Iritz. McGraw-Hill, New York. viii + 248 pp., illus. U.S. \$17.95.
- Vertebrates.** 1996. By A., V., and R. Silverstein. Twenty-first Century Books, New York. 64 pp., illus. U.S. \$16.95.
- World's weirdest birds.** 1996. By M. I. Roberts. Troll, Mahwah, New Jersey. 32 pp., illus. U.S. \$12.50.
- You animal: putting humans in their place.** 1996. By J. Booth. Harcourt, Brace, San Diego. 48 pp., illus. U.S. \$15.
- Young explorer's guide to undersea life.** 1996. By P. Armstrong. Monterey Bay Aquarium, Monterey, California. 64 pp., illus. U.S. \$16.95.

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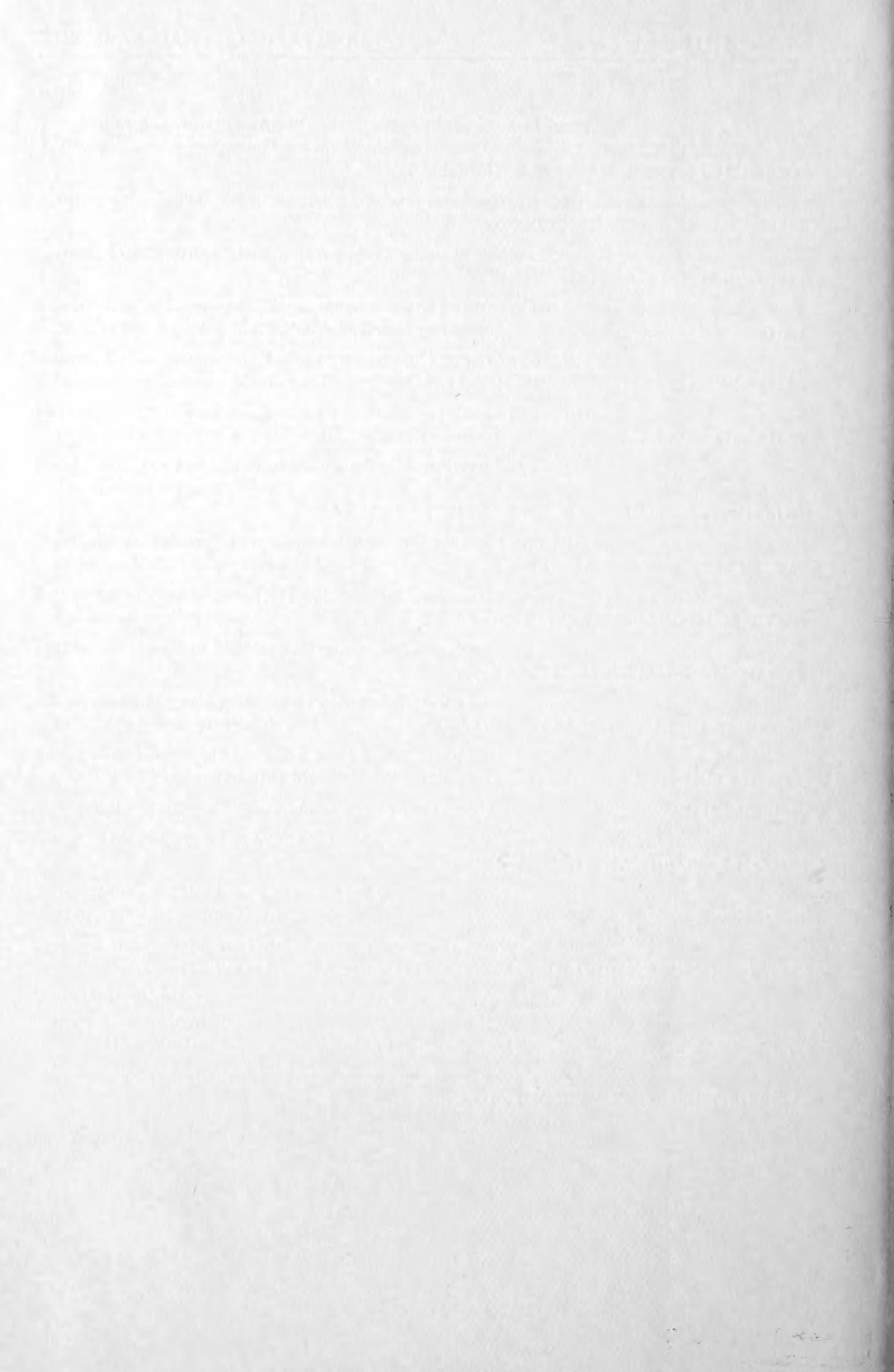
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